I.A.ARO MUSCEL CÎMPULUNG

SERVICE ARO 24
REPAIR HANDBOOK

24 . E-39.07.000

1 FOREWORD

This repair handbook is intended to the personal working in maintenance and repair shops, as a guide for the operations necessary for the cross country cars ARO 24 and its variants, in accordance with the technical documentation and the technical instructions, specific to these types, elaborated by MUSCEL MECHANICAL ENTREPRISE.

It is also used by the specialists, which are leaders of transport entreprises or garages for ARO cars, and by the drivers, pupils from the car drivers and mechanics school.

The present handbook, together with operator's handbook and the spare parts liste, explains the methods to be applied in order to obtain an operationing, maintenance and repairing of quality, which will increase the ARO cars reliability and maintenabilty.

The problems analised in this handbook are of three kinds:

- The everyday's maintenance and service.
- Properly repairing of the motor vehicle.
- The prescribed periods for the operations, mentioned in maintenace and repairing paragraphs.

The first part of the handbook contains instructions for usual maintenance, in various periods, indicated in the SERVICE notebook of the motor vehicle, and the methods for performing of these operations, both during the guarantee period of the motor car and out of it.

The second part shows in detail the methods of symptomatic diagnosticating for various troubles, which can appear during car operation, the methods of remedying them respectively the order for dismantling and refitting the repaired parts, or for changing them; the methods of checking the import and assemblies and parts, for which the functional sizes are indicated, respectively for the repair sizes when this repairing mode is allowed.

The same parts show also the tools, the special devices and verifiers for ARO cars, T.D.V. which are listed in the recapitulative table, at the end of the book, and where is indicated a liste of indexes under which these are manufactured at MUSCEL MECHANICAL ENTREPRISE.

A performed repair will be of high quality only if the remounted parts will be integrate within the allowable wearing limits or will be changed by new, original parts.

The third part of this handbook contains the normed periods, devided for each service operation repair, which can be considered as a calculation base for determining manual labour.

A maintenance and a repair of high quality can be obtained only by respecting strictly the indications of this handbook.

The improving modifications for the ARO vehicles, after or between the handbook issue, are advised to the purchasers by means of the repair hanbook suppliments, which are delivered together with the car.

In the present, third edition are introduced a lot of improvements, in comparison with preceding issue, due to comulating of engine--and motor vehicle repair handbooks, to avoid references from a handkook to the other. The graphic material is also improved, enclosing the figures of the tools, devices and service-verifiers (T.D.V.).

The chapters about repairing and adjusting of body assemblies, of heating system and ventilation, of electrical equipment, etc. are more developed and the grouping of operations is better.

CHAPTER I. GENERALITIES

1.1. METHODOLOGICAL INDICATIONS CONCERNING REMEDYING OPERATIONS

The overhauling operations for the motor vehicle must be done with accuracy. Before any dismantling, the parts and the assemblies surfaces must be cleaned by washing and wipping, in order to obtain them completely dried and clean, as well as the adjacent parts must be cleaned, to avoid impurities to penetrate inside the mechanisms.

If the parts, which are to be dismantled, influence each other, or if they are mounted together, they must be marked by a particular sign, for instance, by slight scratching of the free surfaces, to permit, by refitting them, to obtain again the initial position. The condition is imposed by respecting normal clearances or tightenes, which must be assured.

After dismantling, the parts must be washed in white-spirit or another similar solvent.

On reffering to the plastics and rubber parts, it must be observed that the solvents should not damage them. The parts should be wipped with textile cloth, which produces no lints and they should be checked visually and dimensionally (when the sizes are indicated), in order to discover the faults.

The surfaces which remain free after dismantling of checked parts, should be protected by cartboard, specially in case of opened hausings.

On dismantling assembled parts, it is not allowed to introduce sharp things between thir contact surfaces, in order to remove them.

To facilitate the surfaces'removing, when removing assembled components, it should be performed slight bits, laterally to direction of tightining, by means of a wooden rubber hammer.

If the removing of the two parts does not succeed in this way, one should insist, by washing the contact areas with organic solvents, in order to

soften the paint film, which penetrated in the joint areas of the adjacent sufaces.

Before remounting the dismanled parts, it should be done the last inspection for blows, scratches or impurities. The parts which operate in lubricated spaces, can be lubricated before their remounting with greases or oils of the same quality.

The assemblies, which have oil bath or water chamber (engine block, gear box, differential housing, etc.), must be sealed. Therefore the gaskets, which should be mounted, should be in perfect condition, and the screws (bolts) which are fixing the covers, should be tightened from the center to outside, diagonally and alternatively.

In case that the tightening of bolts has a special importance, such as crankcase main bearing covers or cylinder head fastening bolts the torque indicator wrenches, should be used and the tightening should be done with a torque whose value is indicated in the chapter of respective repair.

In case that a bolt passes through a chamber with fluid, it should be assured a sealing of respective joint, by using sealing solutions (such as "Locktite", "Omrifitt" etc.), which should not block up the bolts. Before applying the sealing solution, the surfaces should be degreased.

The parts which allow remedying by machining, should be machined up to the sizes immediately lower, while the conjugated parts should be choised from the adequate repair class, so that the clearances, respectively normal tightening (indicated in the handbook) could be realized.

The parts for which the repair sizes are not indicated and which exceed the tolerances range, should be repaced with original parts.

If on the ARO vehicle are mounted other engines than ARO L-25 or ARO D-127 (Diesel) engine their derivates, the maintenance indications of the engine supplier should be applied, for the engine and its devices.

1.2. CODITION OF THE MAINTENANCE & REPAIR OPERATIONS

The maintenance & repair operations are marked by a number of 7 (seven) figures.

The number of an operation is diveded into 5 groups separated by points.

The first group has a single figure, that is to say:

- By figure 1: intervention on the vehicle lifted upon an inspecting ramp after returning from the travel, respectively having its lubricants heated up to the working temperature.
- By figure 2: Intervention on the vehicle is made when the vehicle is parked in the workshop or on an inspecting ramp.
- By figure 3: The case when the respective unit is taken down from the vehicle and fixed on a special device which facilitates the operation to be done
- By figure 4: The case when the repair operation is carried out on a normal workshop bench.
- By figure 5: If the respective operation concernes various adjustings and functional tests.

On describing various operations, there will be no refferences, concerning the unit situation (mounted or taken down from the car), but only when it will be strictly necessary.

The second group, having a single figure, "0" or "1", means if the operation is carried out directly, (marked by "0"), or if it needs also other prelimenary operations, (marked by "1"), indicating the order in which these operations must be carried out.

The third group, having two figures indicates the order number of the unit, on which is carried out the operation, so as it is to be seen in the first Table.

The fourth group, having also two figures, indicates the order number of the operation carried out concerning the unit indicated in the second group.

The fifth group, having a single figure, marks the order number of the operation step, marked in the fourth group, as far as this operation is extensive and needs its dividing in successive, characteristic steps; in opposite case, it is marked by "0"

1.2.1 TABEE 1. CODIFICATION OF MAIN UNITS WHICH COMPOSE THE ARO-24 CROSS-COUNTRY CARS

Ref. No.	Name of unit	Code No.
0	1	2
1	Engine - mounted on the vehicle	01
2	Cylinder block	02
3	Cylinder head - (assy)	03
4	Piston and piston rod - (assy)	04
5	Crankshaft - (assy)	05
6	Fuel pump	06
7.	Water pump	07
8	Inlet & exhaust manifolds	08
9	Engine lubricating system	09
10	Engine - taken down from the vehicle	10
11	Fuel supply system, up to the fuel pump	11
12	Exhaust system, beginning from the exhaust manifold	12
13	Engine cooling system - outside of it	13
14	Fuel injection pump	14
15	Carburettor	15
16	Engine clutch	16
17	Gear box	17
18	Transfer box	18
19	Brake and cluch control	19
20	Servobrake	20
21	Front R.H. & L.H. cross propeller shafts	21
22	Rear propeller shafts	22
23	Front differential	23
24	Rear axle	24
25	Rear differential	25
26	Front & rear bumpers	27

1.3. METHODOLOGICAL INDICATIONS FOR TIME NORM ESTABLISHMENT

In the Chapter about the time norms it is indicated the allowed times, in numerical order of the operations to be carried out.

In the time norm are comprised all the preparing stages, necessary for the intervention; as well as these, which are necessary to be able to deli ver immediately the motor vehicle, in good working order, to the owner.

Reffering to the code of operation, one should observe if the second group has the figure "1" or "0".

If there is a figure "0", the time norm will be as such, and the operation will be performed directly, without other prelimenary operations; if there is the figure "1", to the normed time must be added the times provided for the preliminary operations, indicated in the text of the respective operation.

To facilitate this procedure, it is also indicated the page number of the handbook where is found again described the respective operation.

On the vehicles generally overhaulings, the times will be taken as such, without suplementary times for the preliminary operations, and their sum should be corrected by the sub-unitary coefficient K, depending on the equipping degree of the workshop with special T.D.V. (tool . devices . verifiers), specific for the cross-country ARO-cars, and on the yearly series, in which these operations are performed in the respective workshop, as it can be seen in the Table II.

The sum of times should be corrected by the product: $K_1 \times K_2$

TABLE II

Reff. No.	Equipping degree of the workshop and repairs'series	Correction coefficient for endowment - K_1	Correction coefficient for repairs series - K_2
1	Minimal equipping with T.D.V. for SERVICE (T.D.V. marked with astarisk)	0,9	-
2	Equipping with T.D.V. in complete set, as indicated in the handbook	0,75	-
3	Serial repairs, up to 25 per year	-	0,9
4	Serial repairs, up to 26 - 27 per year	-	0,8
5	Serial repairs, up to 76 - 200 per year	-	0,65
6	Serial repairs, over 200 per year	-	0,55

1.4. THE ARO CAR MODELS WHICH ARE REPAIRED ACCORDING TO THIS REPAIR HANDBOOK

1.4.1. The ARO-240 vehicle is intended for goods'and persons'transport,having two lateral doors, rear lower tailgate and a tilt framework with impermeable tilt.

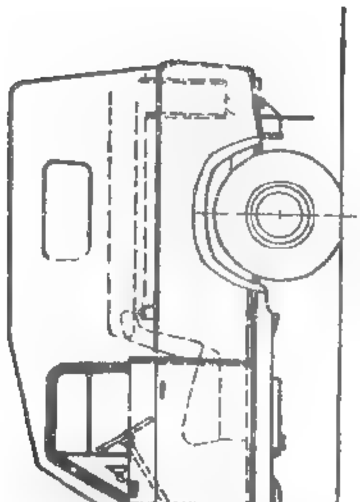


Fig.1.1. ARO 240 OUT ROAD VEHICLE

A vehicle for goods and persons

1.4.2. The ARO-241 vehicle is intended for goods and persons, having four side doors, a rear lower tailgate, the folding rear bench and impermeable tilt.

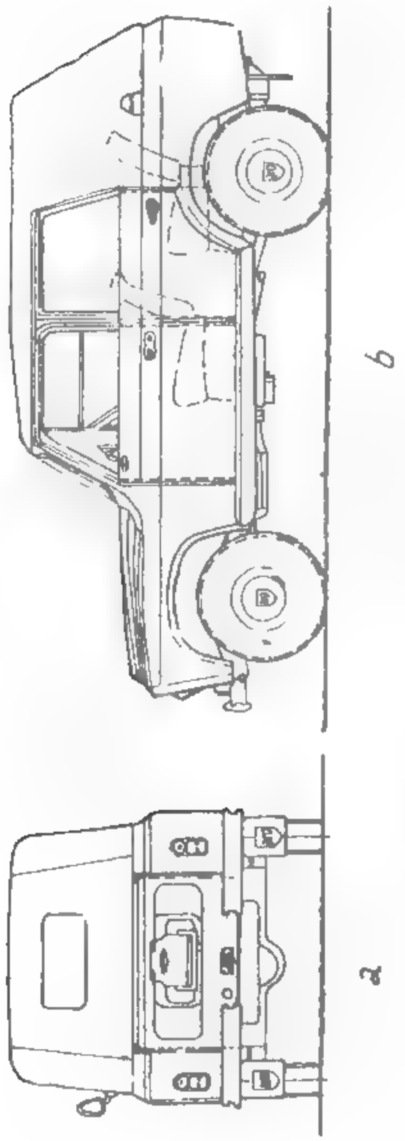


Fig.1.2. ARO 241 OUT'ROAD VEHICLE
A vehicle for persons, having a framework with tilt.

1.4.3. The ARO-242 vehicle is a light pick-up truck, for goods, especially having high specific weight; the bucket can be covered with the til and the driver's cab is metallic, completely closed.

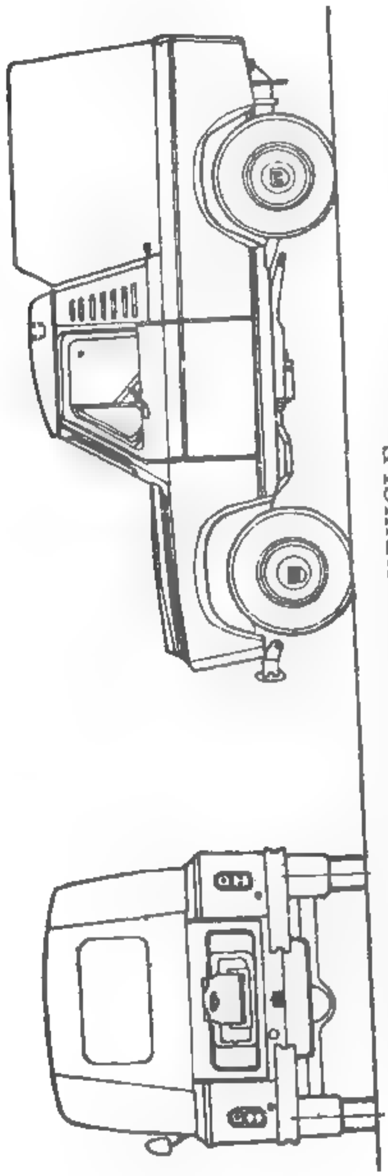


Fig.1.3. ARO 242 OUT ROAD VEHICLE
A pick-up vehicle for goods, with metallic, closed driver's cab.

1.4.4. The ARO-243 vehicle is intended for goods and persons, having two side doors, a rear door and complete metallic body.

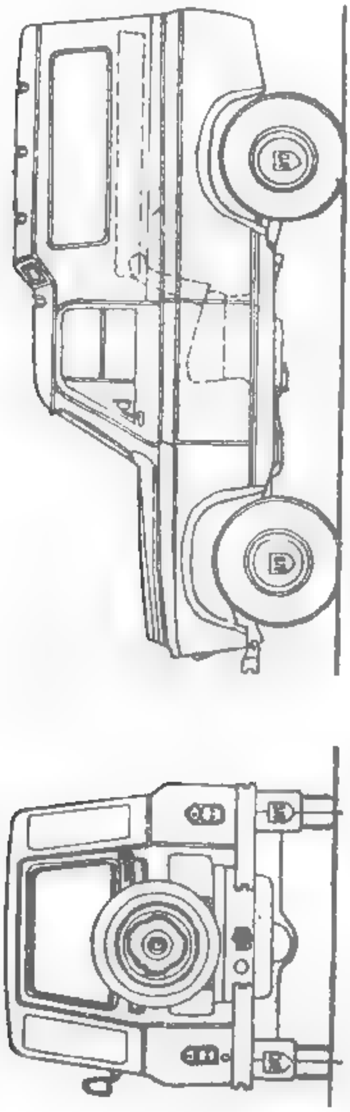


Fig. 1.4. ARO-243 OUT TOAD VEHICLE
A vehicle for goods and persons, having complete metallic body.

1.4.5. The ARO-244 venicle is intended for persons and eventually for goods transport, having four side doors and two rear tailgates (upper and lower), a folding rear bench and complete metallic body.

1.4.6. The ARO-320 vehicle is a pick-up truk, having increased wheelbase, metallic closed cab und independant goods'bucket, with a tilt.

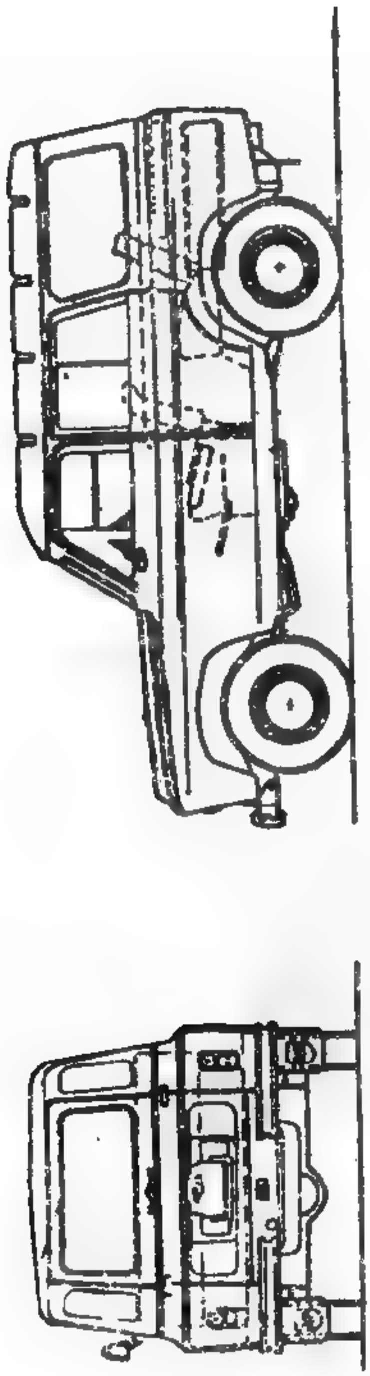


Fig. 1.5. ARO-244 OUT ROAD VEHICLE
A vehicle for persons and small goods having complete metallic body with foor side doors and upper & lower tailgates.

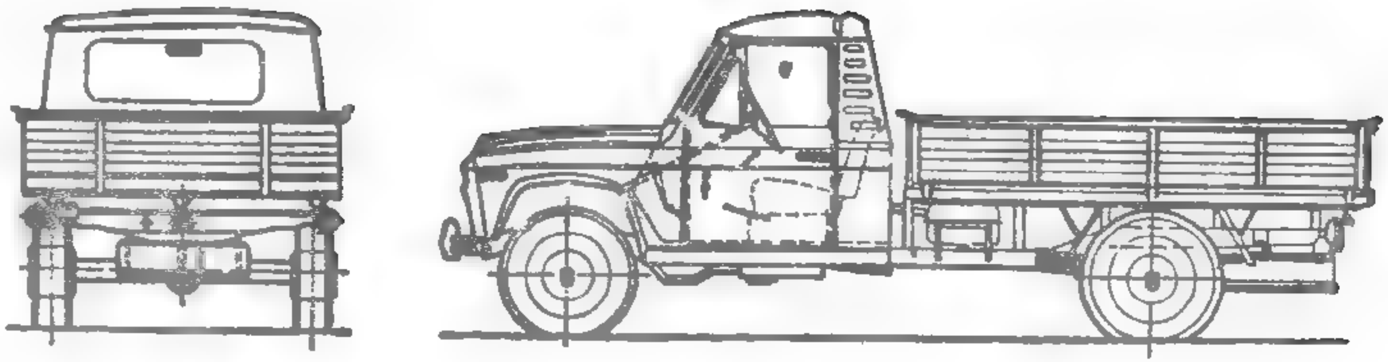


Fig. 1. 6. ARO-320 OUT ROAD VEHICLE
A pick-up slight truck, having metallic, closed driver's cab and a goods bucket with a tilt.

1.4.7. As variants of the above mentioned vehicles are the ARO vehicless with the right hand drive. Within of the handbook, where it will be the case, there will be done references concerning particular operations, depending on R.H. position of the steering wheel.

Another classification of variants is conditioned by the Diesel engine D-127, which equips the ARO vehicles, instead of the ARO L-25 gasoline engine. The overhauling of this engine type is presented in a separate chapter and as far as the other units will be affected by the presence of Diesel D-127 engine, there wil be done necessary references.

1.5. THE LUBRICANTS USED FOR ARO MOTOR VEHICLES

Ref. No.	Name of lubricant	Period of use	Quality: Roumanian	Quality: Equivalent	Handbook symbol	Notes
1.	Engine	In summer	M 30 extra	SAE 40	UL 1	ARO L-25 engine
		In winter	M 20/20 W extra	SAE 10	UL 2	Idem
		t^{o} - $10^{o}C$	Idem	SAE 10	UL 3	Idem
		In summer	M 10 super 2	SAE 30	UD 1	ARO D 127 engine
		In winter	M 20/20 W super 2	SAE 10 W SAE 20 W	UD 2	Idem
2	Transmission oil	Permanently	T 90 EP 2	SAE 90	UT	-
3	Rolling bearings and joints	Idem	UM 175 LiCaPb 3	Multipurpose grease	UR	-

1.6. MUSCEL MECHANICAL ENTREPRISE has a right to assure improvements for ARO motor vehicles, without informing the owners of this handbooks, which handbooks can be completed up to date by procuring the yearly supplement of this repair handbook, which is published yearly, in the first quarter of tne year.

CHAPTER II. CURRENT MAINTENANCE

Manufactured in order to roll at least 120,000 equivalent km, without essential repairs, the ARO vehicles require a dayly current maintenance, consisting of checkings, lubricants changings, cleaning of parts, adjusting the clearings, replacing worn-out parts (oil filtering element, brake piston cups, tires, etc.).

The current maintenance should be carried out by a specialized stuff of the SERVICE-workshops, which are endowed with tools, devices and checkers, specific for ARO vehicles, adequate for all necessary interventions, or in garages, adequately endowed.

2.1. FREQUENCY OF PERIODICAL MAINTENANCE

The current maintenance should be carried out according to the indications of the operator's handbooks, and the SERVICE-botebook.

2.1.1. CAPACITIES: CASINGS RECEIVERS, INTERSPACES FOR LUBRICATING

In the below given Table V are indicated capacities of various casinge, receivers and interspaces, which should be filled withl lubricants or orther functional fluids for ARO motor vehicles, whose characteristics are marked in the Table III or by describing respective operations.

TABLE V CAPACITIES

Ref. No.	Casing receiver, inter-space	Type of fluid	Unit of measure	Feeding point	Capacity	Remarke
0	1	2	3	4	5	6
1	Ignition distributor shaft	Oil	drops	1	3-4	For ARO L-25 engine
2	Gasoline engine oil bath	"	litres	1	5,0	Idem
3	Diesel engine oil bath	"	"	1	6,0	For ARO D-127 engine
4	Diesel engine air cleaner	"	"	1	0,3	Idem
5	Gasoline engine air cleaner	"	"	1	0,3	For ARO L-25 engine
6	Gear box	"	"	1	2,0	
7	Transfer box	"	"	1	1,0	
8	Front differential	"	"	1	1,0	
9	Rear differential	"	"	1	1,2	
10	Propeller shaft head	Grease	kg	4	0,08	
11	Propeller shaft spiders	Grease	kg	8	0,04	
12	Steering gear box	Oil	"	1	0,35	
13	Pivot case	Oil	"	1	0,02	
14	Steering rod heads	Grease	kg	4	0,01	
15	Front suspension linkages	"	"	2	0,01	
16	Wheel roller bearings	"	"	4	0,60	

0	1	2	3	1	5	6
17	Clutch throwout sleeve	Grease	kg	4	0,06	
18	Hinges, latches locks	"	"	-	0,03	
19	Propeller shaft middle bearing	"	"	1	0,25	
20	Outer flange needle bearings	"	"	2	0,01	
21	Storage battery	electro-lyte	litres	1	6,0	
22	Cooling radiator	cooling	litre	1	12,0	
23	Gooling radiator complete	Idem	"	1	13,0	
24	Supplimentary heating system	Idem	"	1	1,5	
25	Simple brake system	fluid	"	1	0,75	
26	Servo brake system	Idem	"	1	0,85	
27	Gasoline/Diesel oil tank	Fuel	"	1	95,0	
28	ARO 320 fuel tank	Fuel	"	1	90,0	
29	Windscreen washing system	washing fluid	"	1	1,0	
30	Supplementary engine oil cooling system	oil	"	1	1,0	For ARO L-25 engine
31	Hydraulic clutch control system	Brake fluid	"	1	0,3	

2.1.2. PERFORMING LUBRICATING

On performing lubricating one should take care that during lubricanting operation the impurities or powders from the environment do not penetrate in the lubricated spaces, because they could cause the rapid damaging of lubricated parts

OP. 2.0.01.02.0 - OIL LEVEL CHACKING IN THE ENGINE BATH

Oil level chacking may be done about half an hour after the engine stopping.

Take out the oil gauge and observe the level reached by oil. This should be comprised between the two marks, MIN and MAX. If there are doubts, conserning the level observed on the gauge, this one should be wipped with a cloth, which does not produce lints, and then introduced again in this hole. Then, take out again the oil gauge and check the oil level.

Normally there is a low oil consumation, so that, in a course of time there is a tendency of decreasing to minimal level. By reaching this minimal level, complete the oil with 500 m.l. with freash oil, of the same quality as that in the engine bath, Then wipe the eventual drops of the adjacent parts.

OP. 2.0.01.04.0 AIR CLEANER INSPECTION BY ARO L-25 ENGINE

Disconnect air cleaner from the carburettor connection pipes and the cylinder head connection pipes, by loosening the fastening collars on the filter. Then, by slight lateral blows remove the air cleaner cover (see fig. 2.1.) and observe the clogging degree of the filtering cartridge and the oil condition. In case that the vehicle has operated on the dusty roads, the observed clogging will be greater and it will be necessary a filter washing and oil changing, as described by Op. 2.0.01.05.0.

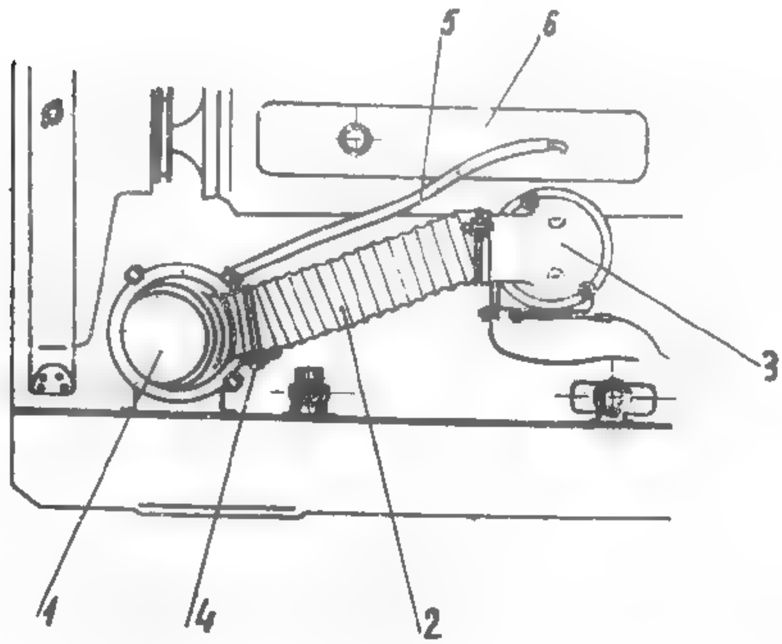


Fig. 2.1. AIR CLEANER CONNECTION TO ENGINE

1. Air cleaner; 2: Connecting hose; 3. Connecting elbow; 4. Hose clamp; 5. Cylinder head cover bleeding tube; 6. Cylinder head cover.

OP. 2.0.17.01.0 OIL LEVEL CHACKING IN THE GEAR BOX

This operation should be performed 5 minutes after stopping the car better on a ramp). A tray for the run-off oil is necessary as well as a source

Lightly remove the level plug (see fig. 2.2.) and in case the oil starts overflowing, immediately replace the plug and fasten it, because there is enough oil. Otherwise, top up with the same transmission oil through the filling hole, till the oil starts flowing out at the level plug hole. After topping up, replace and fasten the plugs.

If there are available specialized oil supplying systems, under pressure, the filling with oil can be carried out by means of a sonde, through the level plug hole till the oil begins to drop out around the sonde (see fig. 2.2.).

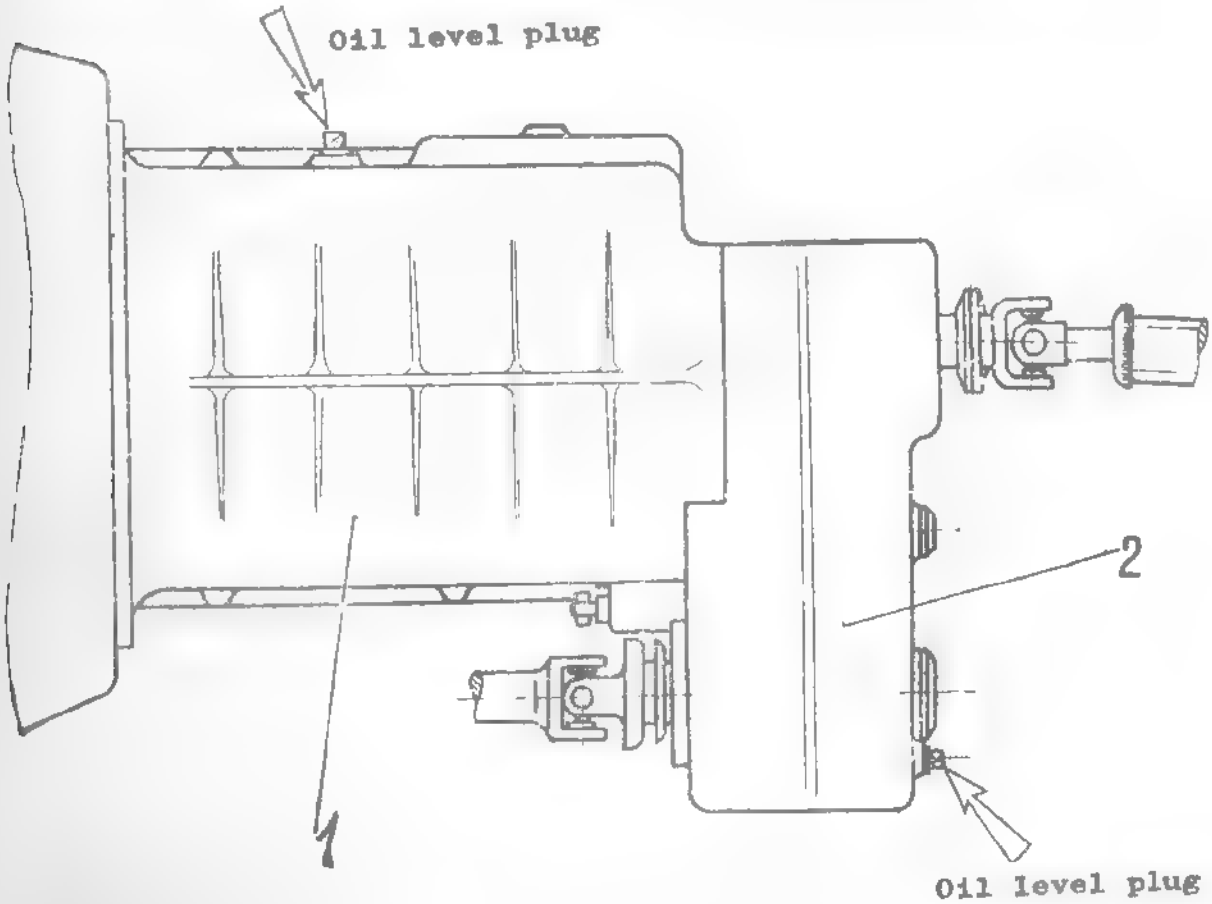


Fig. 2.2. TOP VIEW OF GEAR TRANSFER BOX
1. Gear box; 2. Transfer box; (the arrows indicated the oil level plugs).

Then replace the level plug (and the filling plug also, if it was removed) and wipe dry the adjacent areas, eventually touched by oil.

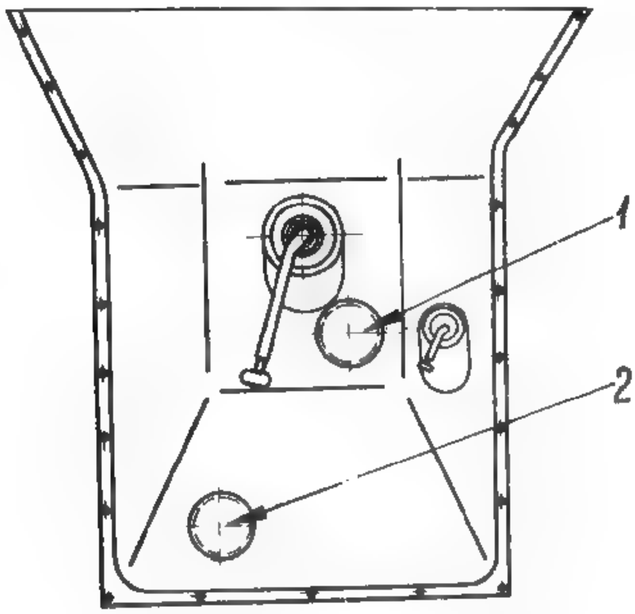


Fig.2.3. LOCATION OF GEARBOX TRANSFERBOX FILLER PLUGS.
1. Inspection cover of gearbox filler plug;
2. Inspection cover of transfer box filler plug.

OP. 2.0.18.01.0 OIL LEVEL CHECKING IN THE TRANSFER BOX

This operation is to be performed similarly as for the gearbox. (see Op. 2.0.17.01.0), manipulating this time the plugs of the transfer box.

OP. 2.1.34.03.0 OIL LEVEL CHECKING IN THE STERING GEARBOX

The steering gearbox plug is accesseble only after removing the air cleaner (the stages 2.0.08.01.1 and 2.1.08.01.2). Therefore it is recommended to performe this operation at the same time with the cleaning of the air clea-

Remove the plug, placed on the top of the steering gearbox and in case the oil level does not longer reach the plug, top it up using the same transmission oil (indicated in this handbook).

Refit the plug and remount the air cleaner in reverse order as by dismantling.

OP. 2.0.23.01.0 OIL LEVEL CHECKING IN THE FRONT DIFFERENTIAL

It is preferable to performe this operation on a ramp, having at disposal a tray for the run-off oil as well as a source of transmission oil.

This operation should be performed 5 minutes after stopping the car, in order to let oil to gather at the bottom of the bottom of the differential housing

Remove the upper filling plug and check if oil is at the hole edge or is drppping out over this. If there will be not enough oil it must be completed till it begins to flow out.

Replace the gasket and the plug. The plug should be clean on replacing. The run-off oil should not be used again.

OP. 2.0.25.01.0 OIL LEVEL CHECKING IN THE REAR DIFFERENTIAL

This operation is to be performed similarly as for the front differetial (Op. 2.0.23.01.0). The level plug is located on the rear axle housing, on its upper side, facing with the differential.

OP. 2.0.01.01.0 D OIL LEVEL CHECKING IN THE D-127 ENGINE BATH

This operation is identical with that, which was indicated for the ARO L-25 engine (Op. 2.0.01.02.0), with the different location only of the oil level gauge.

OP. 2.0.01.01.0 LUBRICATING THE BREAKER CAM OF THE ARO-L-25 ENGINE IGNITION DISTRIBUTOR

Remove the cover fastening clamps of the ignition distributor, together with the ignition wire set.

Take out the oil gauge from the engine oil sump and let drop some oil drops upon the felt of the distributor cam shaft head.

Push back the oil gauge in its hole; replace the cover in its normal position and fasten it with the clamps (see fig. 2.4.).

Check correct connection of the ignition wires.

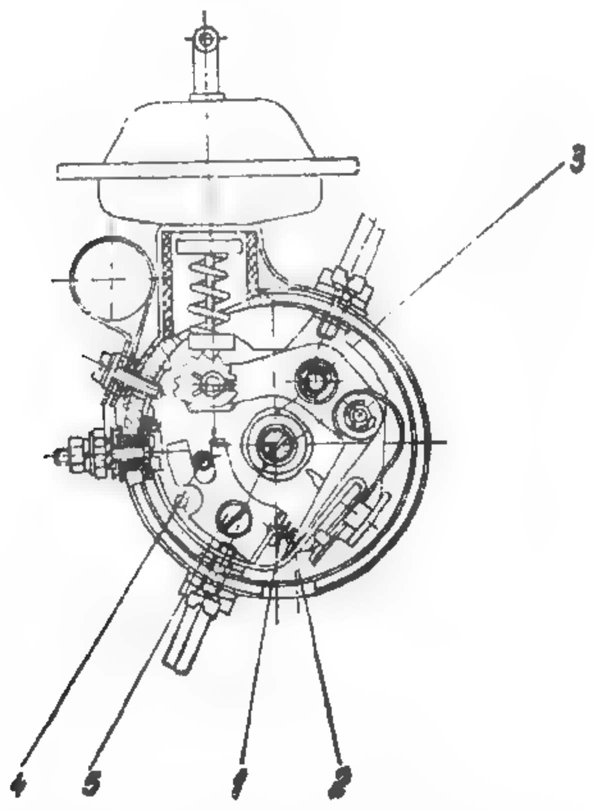


Fig. 2.4. TOP VIEW OF IGNITION DISTRIBUTOR WITH REMOVED COVER.
1. Fixed contact; 2. Breaker arm point; 3. Breaker cam; 4. Adjusting screw; 5. Screw fastening fixed point plate.

OP. 1.0.01.03.0 OIL CHANGING IN THE ARO L-25 ENGINE BATH

This operation should be performed, stopping the engine, 5 minutes after the engine reached its working temperature, in order to be able to drain the oil out from all the components of the engine.

The draining of oil can be performed throug the magnet plug hole, placed at the bottom of the oil bath, or by drowing oil by means of a sonde, through the oil gauge hole. Before draing oil, remove the filling hole cap placed on the cylinder head cover.

In case the oil bath is drained by running-off, put firstly a tray under the magnetic plug and unscrew it. When the oil running-off occures not flowing, but dropping, wipe off any possible impurities from the magnetic plug and rescrew it tightly. Check firstly if its gasket is in good condition.

In case of drawing out the oil by means of a sonde, first remove the oil level gauge (dip rod) and then introduce the sonde through the hole. Oil is sufficiently eliminated when the sonde can no longer draw out but fine drops. In this case also it is useful to unscrew the oil bath plug and remove eventual impurities, collected by the magnet.

Replace the magnetical plug and after pulling out the sonde, introduce again the oil gauge in its hole, after having wipping it off of possible impurities.

Refeeding of engine with fresh oil is carried out through the oil filler cap, on the top of cylinder head. After, that, replace the oil filler cap and fasten it by slight turning.

OP. 2.0.01.05.0 OIL CHANGING IN THE AIR CLEANER

The operation is carried out in several stages:

St.2.0.08.01.1 DISCONNECTING AIR CLEANER FROM THE ENGINE

Remove hose clamps which fasten the hoses on the air cleaner connecting sockets, and namely: from the connecting hose to carburettor and from the aeration hose of cylinder head. (see fig.2.1.).

On remounting the operations should be done in reverse order.

St. 2.1.80.01.2 TAKING DOWN AIR CLEANER FROM THE ENGINE

This stage is performed by disconnecting air cleaner from the engine, respectively by performing the stage 2.0.08.01.1.

Loosen the clamp fastening the air cleaner on the inner wing (the mud-guard), by removing the nut (acces through the space for wheel).

Bemove the air cleaner from the clamp.

On remounting the operations should be done in reverse order.

St. 2.0.08.01.0 CLEANING OF THE AIR CLEANER FILTERING ELEMENT

Remove the clamps fastening the cover on the cleaner body and, by slight lateral blows remove the cleaner cover.

Wash filtering element in gasoline or white spirit, in a specially provided room, to avoid fire risks.

Empty out the used oil from the cleaner housing and wash the housigg just like the filtering element.

Pour into cleaner housing fresh oil and replace filtering element, fastening it with the clamps.

OP. 1.0.17.02.0 OIL CHANGING IN THE GEABBOX

This operation should be performed about 5 minutes after coming back from a journey, while the gearbox is still hot and the oil could run-off as possible completely.

Take off the inspection rubber cover from the gearbox hood (see fig. 2.3) as well as the gearbox filling plug.

Place under the vehicle, facing the gearbox, a collecting tray, and remove the oil level plug and then the draining plug from the lower side of the gearbox, letting the used oil to flow out.

Pour fresh oil, of indicated quality and quantity through the filling hole till the oil starts flowing through the oil level hole.

If a supply system under pressure is available, feed with oil through the oil level hole, by means of a sonde. The feeding should be continued till oil begin to drop out through the oil level hole.

Screw back the level and the filling plugs; then wipe thoroughly all traces of oil to avoid collecting of impurities and to be able to descover eventual oil leakages.

OP. 1.0.18.02.0 OIL CHANGING IN THE TRANSFER BOX

This operation is to be performed as for the gearbox, the plugs having identical functions. (see Op. 1.0.17.02.0).

OP. 2.0.22.01.0 LUBRICATION OF PROPELLER SHAFT SLIDING YOKES.

Move the vehicle so that the grease nipples, placed on the sliding yokes of the propeller shafts, reach successively a suitable position for greasing.

By means of a grease gun push grease through the nipples of the sliding yoke until it begins to emerge through the hole of the cover, which obturates the splined bore, towards the cardan joint.

OP. 2.0.22.02.0 LUBRICATION OF PROPELLER SHAFT SPIDERS

Move slightly the vehicle so that the grease nipples, placed on the cardan spiders, reach successively a [illegible] position for greasing. By means of a grease gun push grease thr[illegible]e nipples, untill it begins to leak around the needle bearings. Wipe [illegible] of grease.

OP. 2.0.34.01.0 LUBRICATION OF STEERING KNUCKLE PIVOT

This operations is performed by means of a grease gun, pushing grease throught the grease nipple, placed on the cover plate protecting the pivot. The access to this place is below the engine bonnet.

Remove excesse of grease, by wipping dry.

OP. 2.0.34.02.0 LUBRICATION OF DRAGLINK ROD HEADS

This operation is performed by means of a grease gun, pushing grease through the grease nipples, mounted on the rod heads.

Push grease up to refuse. Wipe then the excess of grease.

To facilitate this operation lift the vehicle on ramp.

OP. 1.0.23.02.0 OIL CHANGING IN THE FRONT DIFFERENTIAL

This operation should be performed about 5 minutes after coming back from a journey, so that oil will be still hot and could run-off as possible completely.

Put under the differential a collecting tray and then unscrew, successively the oil level plug and the drain plug.

Let oil run off untill it begins to drop rarely.

Wipe impurities on the drain plug and screw it, together with its gasket.

Feed differential with fresh oil, through the oil level hole, until oil begins to flow out around the feeding sonde.

If measuring possibilities are available, pour oil in prescribed quantity.

Wipe impurities on the oil level plug and screw it, together with its gasket.

OP. 1.0.25.02.0 OIL CHANGING IN THE REAR DIFFERENTIAL

The operation is performed in the same way as for front differential. (see Op. 1.0.23.02.0).

OP. 2.0.29.01.0 LUBRICATION OF FRONT SUSPENSION LINKAGES

The operation is performed easier when the vehicle is lifted on a ramp to permit the simultaneous upper and lower access.

By means of a grease gun push grease into grease nipples provided in the extremity areas of the R.H.& L.H. steering knuckles.

Wipe grease excess from the adjacent areas.

OP 1.0.01.01.0 D CHANGING OIL IN THE DIESEL D-127 ENGINE BATH

This operation is identical with the same operation for MM ARO L-25 engine (see Op. 1.0.01.03.0). The only differences are the lubricant quality, the positions of the drain plug and the oil filler cap of cylinder heads.

OP. 2.1.16.01.0 LUBRICATING THE CLUTCH THROWOUT SLEEVE

This operation is rather difficult to be performed, due to difficult access in to the lubrication area.

It is necessary to take down transmission tunnel cover, to have access throught the clutch cover opening. or to take down the lower clutch housing cover.

St. 2.0.53.01.0 TAKING DOWN OF THE TRANSMISSION TUNNEL COVER

Remove the control level knobs of the gearbox and transfer box, in order to slide off the rubber protecting boots from the levers.

Remove the screws fastening the transmission tunnel cover on the floor pan and the cowl and lift the cover, by sliding the rubber boots, taking it completely down or making only enough space for access in the working area.

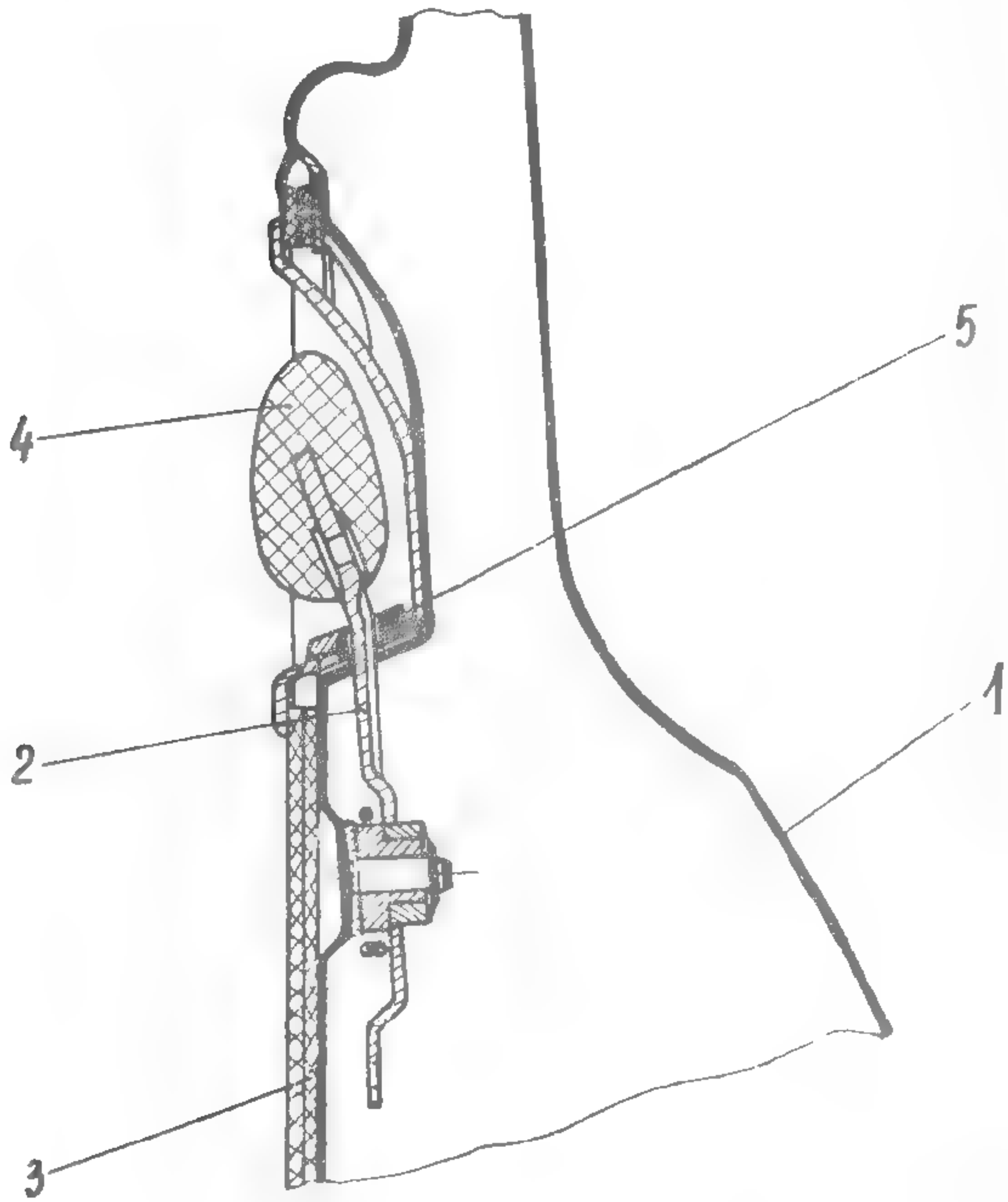


Fig. 2.5. INNER FRONT DOOR LOCKING HANDLE
1. Outer front door panel; 2. Inner locking; handle; 3. Door upholstery; 4. Locking handle knob; 5. Ornamental plate.

Remounting is performed in the reverse order.

St. 2.0.16.01.1 LUBRICATING OF THE THROWOUT SLEEVE

Apply grease with a wooden spattle on the gerabox flange, operating in the same time the clutch pedal in order to make slide the throwout sleeve and to grease it on the whole surface.

Pay attention to not let grease in excess, which could reach accidentally on the cluth friction disc, what could generate difficulties in its operation.

OP. 2.0.99.01.0 LUBRICATION OF DOOR LOCKS, HINGES LATCHES

Grease the door mechanisms, locks and tailgate latches as follows:

St. 2.0.61.01.1 DISMANTLING OF FRONT DOOR UPHOLSTERY

Dismantle, by pulling off, the knob of the inner door locking handle.

Dismantle the handle ornamental plate, and its shell, by removing the fastening screws (see fig. 2.5.).

Take down the arm-rest, removing the M 6 hexagonal screws, by means of a box wrench (see fig. 2. 6.)

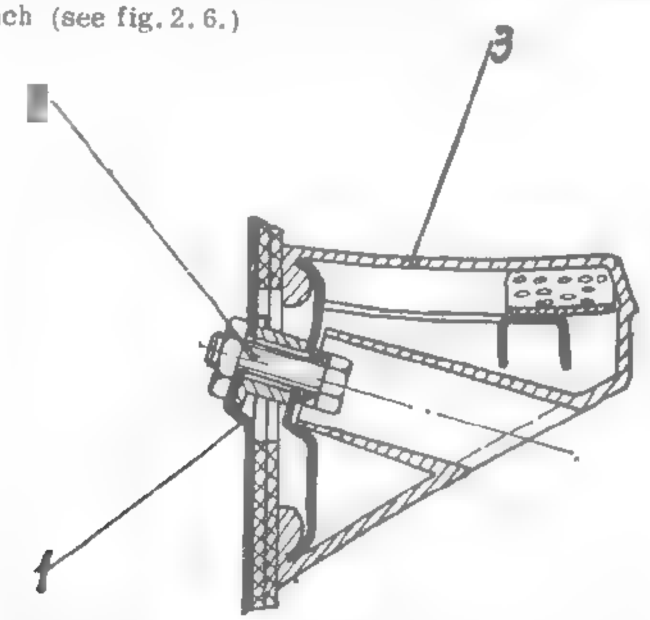


Fig. 2. 6. ARM-REST FASTENING ON THE DOOR PANEL
1. Inner door panel; 2. Fastening screw; 3. Arm-rest.

Remove from the central side of the window reggulator handle, paying attention to not damage it, and remove the nut fixing the handle on the shaft.

Remove, by axial drawing, the window regulator handle and its cover plate (see fig. 2. 7).

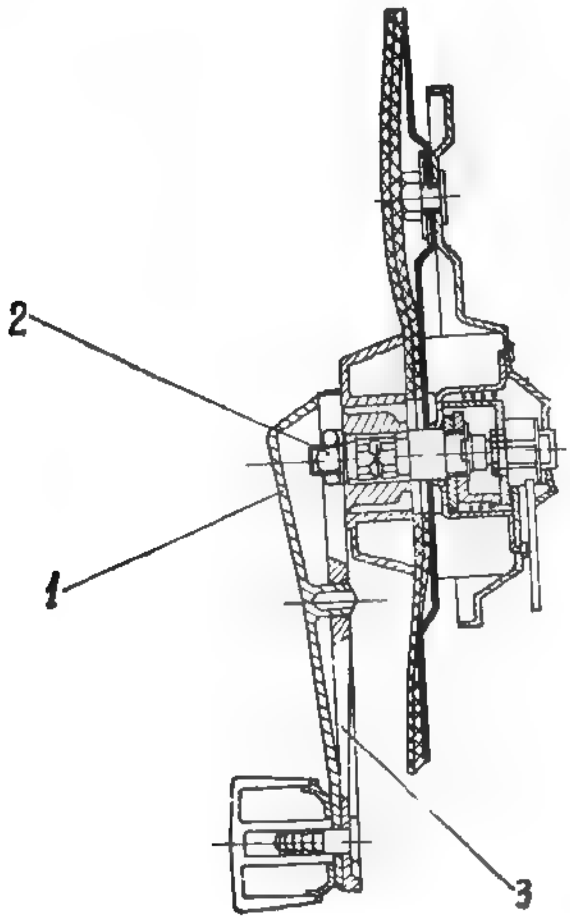


Fig. 2. 7. WINDOW REGULATOR HANDLE
1. Handle revetment; 2. Fastening nut; 3. Window regulator handle.

Remove the buttons fixing the upholstery on the door and then remove the upholstery from the door outside panel.

By removing buttons, draw out firstly the inner piece and then the outer one.

By remounting the upholstery, performe the operations in reverse order. Before remounting, wipe the upholstery with a detergent solution, then with water, to remove detergent and finaly wipe it dry.

St. 20.61.01.2 LUBRICATION OF THE FRONT DOOR MECHANISMS

Through the openings of the inner door panel lubricate, by means of a wooden spattle, without laying grease in excess, the window regulator mechanism, and namely: toothed quadrant; linkage joints.

The greas ing the door locking mechanism: door lock handle joint, the door lock and safety locking device.

ADVISE: Do not lubricante the lock, incorporated in the outer door handle, to avoid its blocking by dust or its freezing in winter.

The door hinges should be lubricated with oil.

St. 2.0.62.01.3 DISMANTLING OF REAR DOOR UPHOLSTERY

Take down the ash tray.

Take down the arm-r st (see fig. 2.6).

Remove by axial drawing, the knob of the inner door locking handle.

- Dismantle the ornamental plate and the shell of the locking handle. (see fig. 2.5.).
- Remove the crane handle.
- Remove the buttons fixing the upholstery on the inner door panel. By removing buttons, draw out firstly the inner pieces.
- Take down the door upholstery from the upper and lower guide.
- The upholstery remounting should be performed in reverse order.

St. 2.0.62.0.1.4. LUBRICATION OF REAR LATERAL DOOR

- Through the openings of the inner door panel lubricate; by means of a wooden spattle, without laying grease in excess, the door locking mechanism and the inner handle joint.
- The door hinges should be lubricated with oil.

St. 2.0.56.01.5 LUBRICATION OF LOWER TAILGATE LOCKING DEVICE

- Open the lower tailgate and lubricate with some drops of oil the latch, operating it concomitatly from outside, in order to lubricate the contact faces between the latch and its guide in the tailgate (see fig. 2.8.).

- Lubricate also the lower hinges of the tailgate.

- Remove oil in excess by wiping. Do not let oil to flow on the painted surfaces.

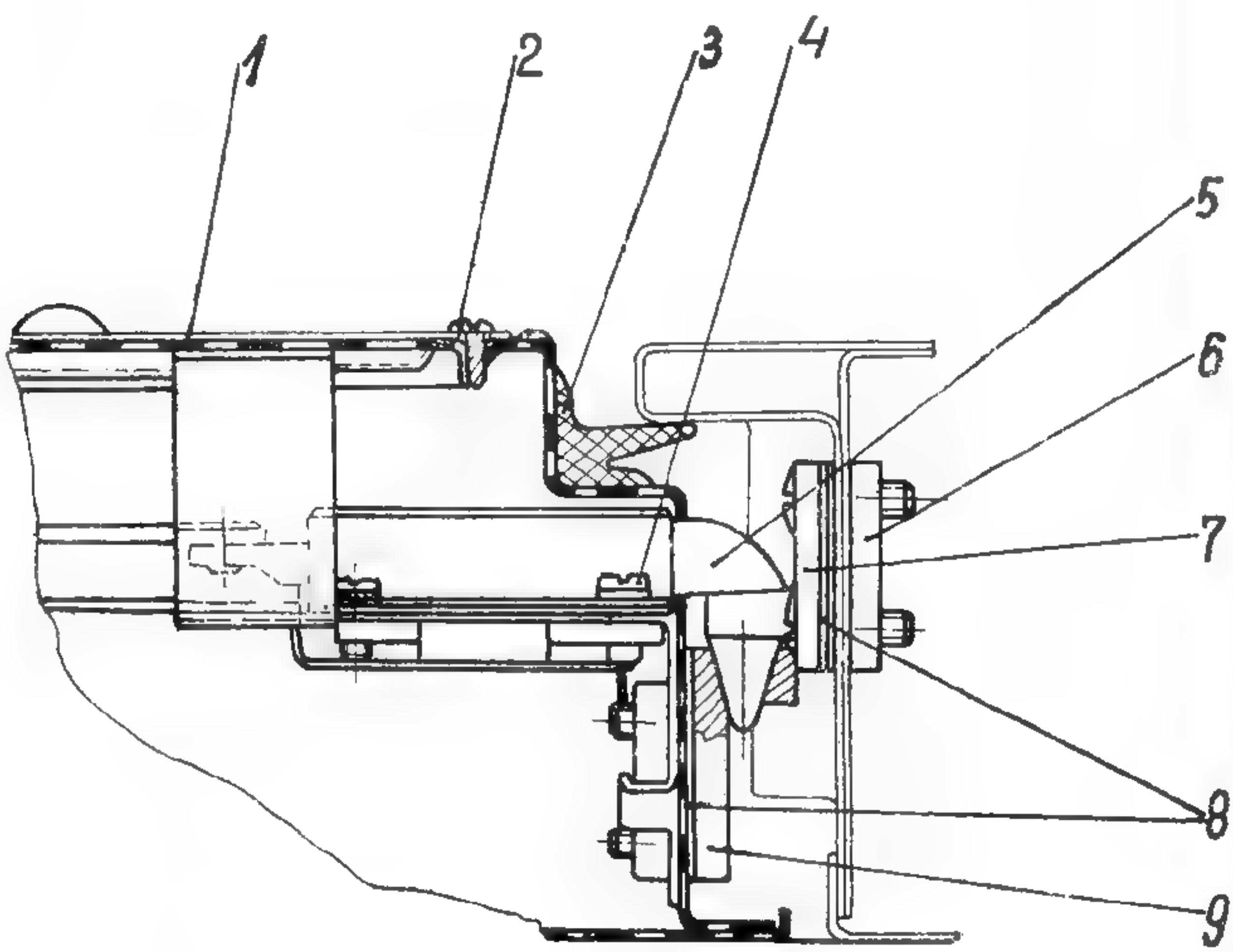


Fig. 2.8. LOWER TAILGATE LOCKING DEVICE
1. Obturating cover; 2. Screw; 3. Weather strip; 4. Screw; 5. Locking device; 6. Threaded plate; 7. Wedged plate; 8. Adjusting spacer. 9. Wedged mobile bridle .

St. 2.0.56.01.6 LUBRICATING UPPER TAILGATE SUPPORTING DEVICE

- Lift up upper tailgate and lubricate with some drops of oil its supporting device, the latch and joints.

- Lubricate also the upper hinges.

- Remove excess of oill by wiping. De not let oil to flow on the painted surfaces.

- Do not lubricate the key lock to avoid its blocking, specially in winter, by freezing.

St. 2.0.63.01.7 DISMANTLING REAR DOOR UPHOLSTERY

- Draw out the buttons fastening the upholstery on the rear door; after that, remove the panels. By removing the buttons, draw out firstly the inner piece and then the outer one.

St. 2.0.63.01.8 LUBRICATING REAR DOOR LINKAGES

- Through the openings of the inner door panel lubricate, by means of a wooden spattle, without laying grease in excess, the mechanism of inner handle.

- Do not lubricate the key lock to avoid its blocking.

- Let some drops of oil upon the door hinges and door lock strikers.

OP. 2.1.34.04.0* OIL CHANGING IN THE STEERING GEARBOX
- VERSION BY DISMANTLING -

- Take down air cleaner from the car, according to Op. 2.1.08.01.2.

Since the draining of steering gearbox can be performed only through the filler plug hole and it is necessary to take down the steering gearbox, it is advisable to perform oil changing when the steerin gearbox is taken down for other maintenance operations also.

For taking down of steering gearbox there are necessary many preliminary operations, as: dismantling of drop-arm, electrical disconnecting of steering gearbox, undoing the joint with steering wheel axle.

St. 2.0.34.04.1 DISMANTLING THE DROP-ARM

- Remove th split pin and the nut, fastening the drop-arm.
- Mark the mutual position of the drop-arm and its shaft.
- Remove drop-arm by means of D.148 extractor.

By refitting.take care to respect correct position of drop-arm on its shaft. By assembling drop-arm on shaft splines, use a rubber ot plastic hammer.

- Srew the nut with a socket wrench, up to refuse, and secure nut with a new 5,0 x 25 split pin.

St. 2.0.34.04.2 ELECTRICAL DISCONNECTING OF COLUMN

- Remove the split pin and the screw fastening stearing shaft in steering shaft flange.
- Mark mutual position between axle and flange, taking into account that the fastening screw passes partially through the steering shaft, securing position blocking, so that refitting in another position gets impossible,
- Loosen U-bolt fastening steering column on cowl.
- Loosen U-bolt fastening steering column on facia panel.
- By means of a rubber or plastic hammer blow slightly the joint of upper and lower steering shafts, until the splines of lower shaft come out from the flange.

On refitting performe the operatins in reverse order and use new splint pins.

St. 2.0.34.04.4 TAKING DOWN STEERING FROM THE CHASSIS

- Remove split pins securing the nuts which fasten steering gearbox.
- Unscrew the nuts, draw out the fastening bolts and remove steering

On remounting, performe the operations in reverse order and use new split pins.

St. 2.0.34.04.5 OIL CHANGING IN THE STEERING GEARBOX, BY DRAINING

- Remove the filling plug and let oil flow out until it will drop rarely.
- Pour fresh oil up to the filling hole edge and replace the filling plug, after having wiped it from impurities.

OP. 2.0.34.06.0 OIL CHANGING IN THE STEERING GEARBOX, BY MEANS OF A SONDE

- If in the workshop is available a sonde for drawing out oil from housings, annex at its end an elastic, plastics tube, which would allow its moulding inside of the gearbox.
- Remove filling plug, push in the hole the elastic tube, up to the lower place of the gerabox and draw out oil, until it will be delivered dropwise.
- Pour in fresh oil up to the filling hole edge and replace the filling plug, after having wiped it from impurities.

OP. 2.1.31.01.0 LUBRICATING FRONT WHEEL BEARINGS

As far as lubrication of bearing should secure grease penetrating between the rolling components, their greasing can be performed only by their dismantling from the wheel hub, respectively from the outside flange journal.

St. 2.0.31.01.1 TAKING DOWN THE WHEEL

- Lift the car using a jack, which should be propped as indicated in fig.2.9, until the wheel will rise 10...15 mm over the ground

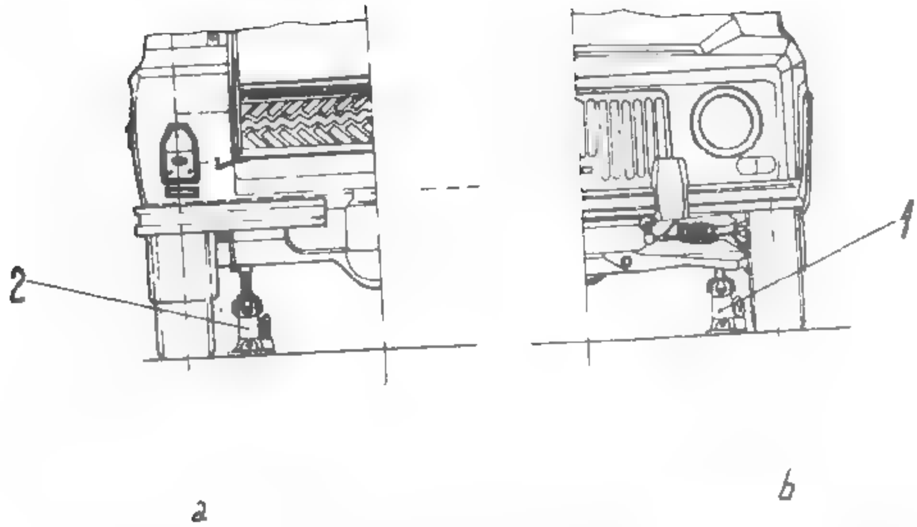


Fig.2.9. FITTING HYDRAULIC JACK ON TAKING WHEELS DOWN
1. Fitting jack on taking front wheel down; 2. Fitting jack on taking rear wheel down.

- Unscrew the wheel nuts, by means of a pneumatic wrench (for M 14) or by means of the starting handle from the car's tool outfit.

- Remove the wheel (30 kg weight), lifting it slightly, in order to not damage the wheel bolts.

- On remounting the wheel performe the operations in reaverse order.

- On screwing back the nuts draw up firstly two opposite nuts, in order to secure correct seating on their tapered faces.

- During the definitive tightening, up to refuse, with the minimal force, by means of the starting handle, tighten each second nut rotating every time the wheel.

St. 2. 0. 31. 01. 2 STRAIGHTENING FRONT WHEEL DRIVING JOINT - VERSION WITH DRIVING BUSHING (CONNECTING FLANGE)

- Remove the hub cap.

- Remove the axle cap, by means of S.121 extractor, and the O-Ring seal (see fig.2.10).

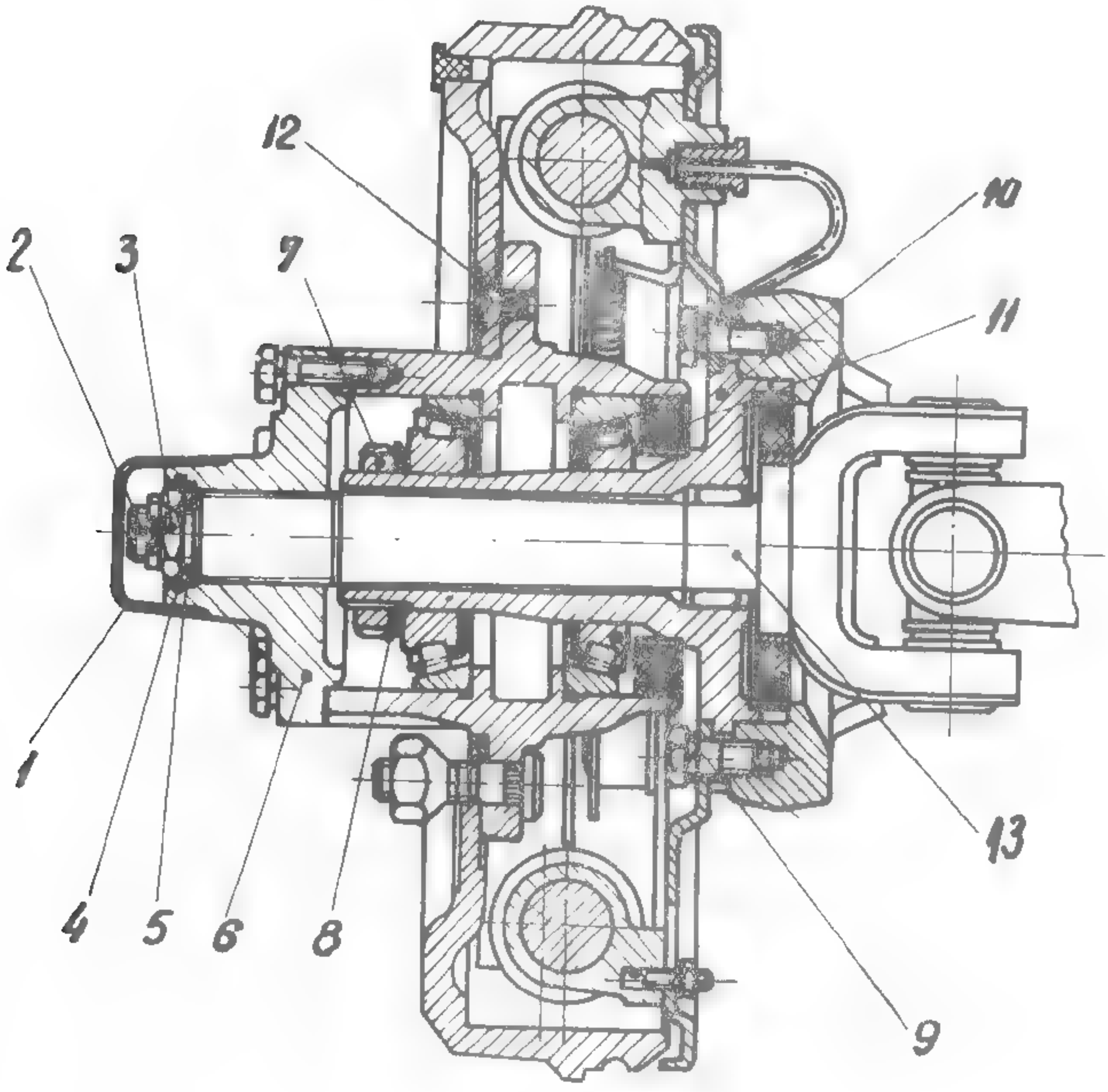


Fig. 2. 10. FRONT WHEEL BRAKE DRUM KING PIN ASSY.
- VERSION WITH DRIVING BUSHING -
1. Axle protecting cap, 2. Split pin; 3. Nut fastening king pin. 4. Lock washer; 5. Thrust washer, 6. Driving bushing; 7. Bearing securing nut; 8. Bearing nut lock plate; 9. Inner bearing race; 10. Outer flange. 11. Oil sealing ring, 12. Brake drum fastening screw: 13. King pin.

- Remove the split pin, securing steering knukle nut.
- Unscrew the nut fastening driving bushing on steering knukle.
- Unscrew the bolts fastening driving bushing on brake drum and remove the bushing and gasket.

When reassembling, perform the dismantling operations in reverse order, and check if gasket is not damaged. Use a new split pin.

By fastening steering knukle nut the wheel should be turned in the inner limit position.

St. 2.0.31.01.3 DISMANTLING FRONT WHEEL DRIVING JOINT
- VERSION WITH FREE WHEELING FRONT HUBS -

- Unscrew bolts fastening the free wheeling hub cover and remove the cover (2) (see fig. 2.11).
- Remove the split pin (5) and uscrew the nut (6), fastening the free wheeling hub on steering knukle (10).
- Remove snap ring (7) and thrust washer (8) by means of special S 102 nose pliers.
- Unscrew bolts (4) fastening free wheeling hub on the steering knukle (10) and remove it by axial sliding.

When refitting, perform the dismantling operations in reverse order, using a new split pin. By tightening the nut (6) the wheel should be deflected in the inner limit position.

St. 2.0.31.01.4 REMOVING FRONT WHEEL OBTURATING COVER
- VERSION WITH UNDRIVING WHEELS -

- Unscrew bolts fastening the obturating cover on the brake drum hub and remove the cover and its gasket.

When refitting check if the gaslet is not damaged.

St. 2.1.31.01.5 TAKING BRAKE DRUM HUB ASSY DOWN

- Undo lock plate securing nut which fastens the bearing and then uscrew the nut by means of special S 103 wrench.

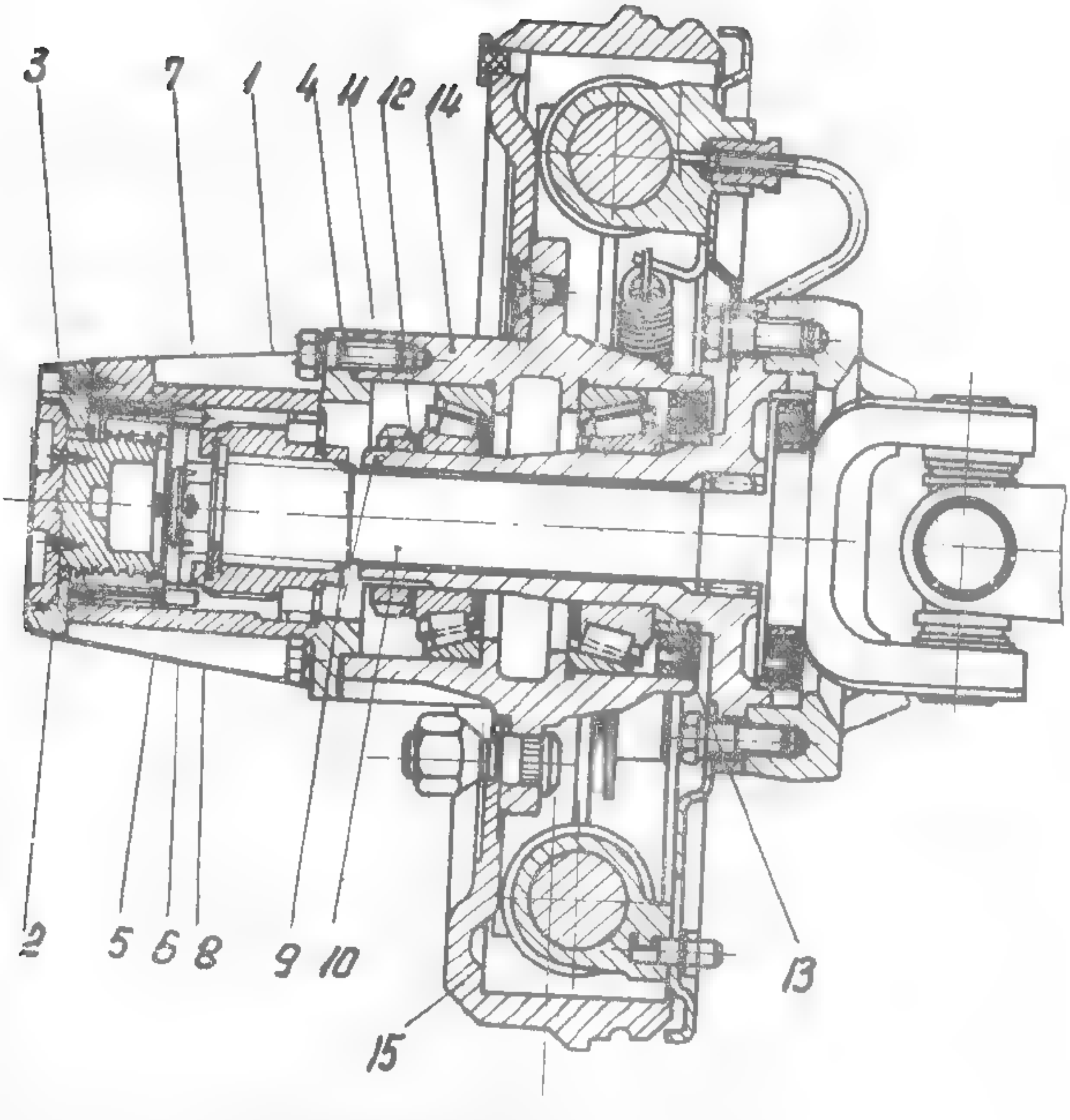


Fig. 2.11. FRONT WHEEL BRAKE DRUM GING PIN ASSY
- VERSION WITH FREE WHEELING HUB -
1. Free wheeling hub assy; 2. Free wheeling hub cover; 2. Fastening screw; 4. Bolt fastening free wheeling hub on wheel hub; 5.Split pin; 6. Nut fastening free wheeling hub on king pin; 7. Snap ring; 8. Thrust washer; 9. Outer flange; 10. King pin; 11. Nut securing wheel bearing; 12. Bearing nut lock plate; 13. Oil sealing ring; 14. Wheel hub; 15. Brake drum.

- Remove brake drum by axial sliding, by means of D 101 extractor.
- Pay special attention to operation accuracy.

If the bearing inner race is left on the outer flange remove it by means of D 102 extraction device.

If during the brake drum extraction it is found that the hub sealing ring id damaged, remove it by means of D 103 extraction device, in order to replace it with a new one.

- On refitting the sealing ring press it into the brake drum by means of S 106 mandrel, after having pressed into the wheel hub the inner race of inner bearing.
- On refitting braking drum upon the outer flange use S 107 mandrel, pressing the inner race of outer bearing,

Put back the thrust washer (8) and snap ring (7) and tighten the nut (6), by means of S 103 wrench (manually), up to refuse, turning concomitantly the drum, in order to secure correct fitting of bearing rollers. In this situation the drum turns with difficulty, but without binding tendency.

- Loosen now with about 1/4 turn the nut. Now the drum will turn easily, but without being perceived any radial or axial play.
- When the loosen nut reaches with its slot the lock plate blade, secure nut by bending the blade into the nutslot.

St. 4.1.31.01.6 GREASING WHEEL BEARINGS

- Wash the drum and its bearings in white spirit, two or three times, each time with fresh solvent, in order ot remove any trace of grease. Pay special attention to operation accuracy and fire danger.
- Check with this occasion the bearing races and rollers for wear traces, such as: superficial exfoliations, fatigue craters, corrosions, tinges owing to unsatisfactory lubrication and overheating of bearings, in such cases the faulty bearings should be changed.
- Introduce, by means of a wooden spattle grease of prescribed quality, between the bearing races and rollers; grease in excess is not useful.

OP. 2.1.31.04.0 GREASING REAR WHEEL BEARINGS

This operation needs preliminary stages, as follows;

- Take down the wheel from de car, according to Op. 2.0.31.01.1.
- Remove wheel driving components, according to Op. 2.0.31.01.1. described
- below.
- Take drum & wheel hub assy. down according to Op. 2.1.31.01.5.
- Grease wheel bearings according to Op. 2.1.31.01.6.

Refitting should be performed in reverse order, by respecting the provisions mentionned for each operation.

St. 2.0.31.04.1 REMOVING DRIVING COMPONENTS OF REAR WHEELS

- Unscrew bolts fastening rear axle drive shaft on the wheel hub (see fig.2.12).
- Remove by axial drawing the drive shaft and the sealing gasket.

On refitting check if gasket is not damaged and perform tha operations in reversre order.

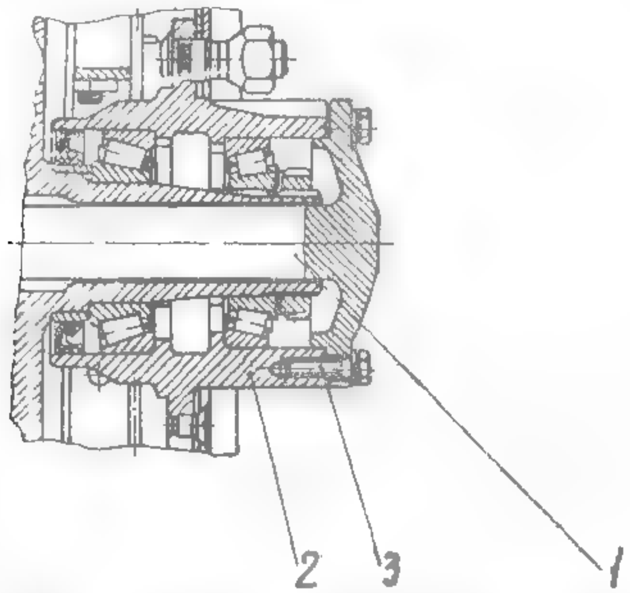


Fig.2.12. REAR AXLE DRIVE SHAFT FASTENING ON WHEEL HUB
1. Rear axle drive shaft; 2. Wheel hub; 3. Bolt fastening. drive shaft on wheel hub.

OP. 2.1.22.03.0 LUBRICATING PROPELLER SHAFT MIDDLE BEARING (Only for ARO-320 pick-up truk)

To lubricate the propeller shaft middle bearing it should be taken down.

St. 2.1.22.03.1 TAKING MIDDLE BEARING DOWN

- Undo the blades of lock plates of the bolts securing propeller shafts on the middle bearing flanges.
- Unscrew bolts and remove propeller shafts.
- Remove wire lock and nut fixing washer from the middle bearing axle, on the rear axle side.
- Holding the opposite nut, unscrew the flange nut and remove the flange from the axle slots. Unscrew bolts fastening the cover on the bearing body.
- Undo split pins of the bolts fasteing the bearing cover on chassis cross-member.
- Loosen the nut and remove the bolts.
- Remove the bolts from the same side where was removed the flange.
  In this situation the middle bearing can be taken down from the chassis cross-member.
  Refitting is performed in reverse order, renewing the split pin.

OP. 4.1.22.03.2 GREASING THE MIDDLE BEARING

- Put the partially dismantled middle bearing into D-118 dismantling device and continue to dismantle the opposite flange, by removing lock plates and nuts.
- Unscrew bolts fastening the opposite cover on the bearing body and remove cover and oil seals.
- By means of a rubber or plastic hammer blow in the axle end, which will come out, on the opposite side, together with on of the two bearings (see fig.2)
- Wash dismantled parts 2 - 3 times in white-spirit, each time fresh, in order to remove completely any trace of old grease.

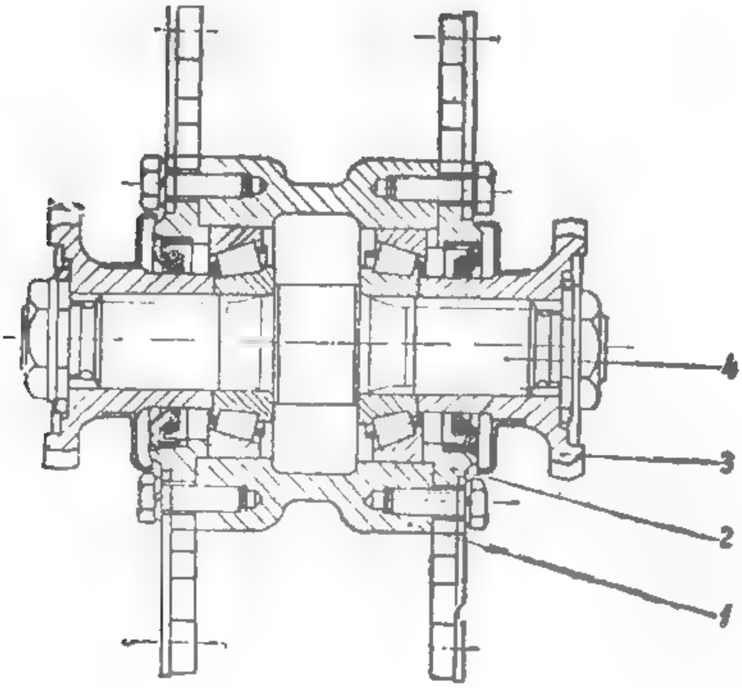


Fig. 2.13. PROPELLER SHAFT MIDDLE BEARING

1. Middle bearing body; 2. Bearing fastening flange;
3. Connecting flange; 4. Middle bearing shaft.

- Before greasing check oil seals and bearings, for wear, pinches, respectively the bearings for superficial exfoliations, fatigue craters, corrosions, tinges due to unsatisfactory lubrication and overheating.
- Perform greasing so that grease penetrates between the rollers, up to the bearing races.

  Grease in excess leads to unsatisfactory lubrication.
- Replace the parts with traces of wear.
- Perform refitting in reverse order.

OP. 2.1.30.01.0 LUBRICATING NEEDLE BEARING INSIDE OUTER FLANGE (see fig.2.10 and 2.11)

- The needle bearings, mounted inside the outer flange, are difficult of access, and need successive dismantling of some assemblies, so that it is advisible to performe this operation concomitantly with greasing of wheel bearings. For this:
- Take the wheels down, according to Op. 2.0.31.01.1.
- Remove front wheels driving components, according to Op. 2.0.31.01.2 or Op. 2.0.31.01.3. By the cars with undriving front axle the needle bearings do not exist in the outer flange.
- Take drum wheel hub assy down, according to Op. 2.1.31.01.5.

  All these operations are common for greasing of front wheel bearings.
- Take brake anchor plates and outer flange down, as described below.

  On refitting performe the operations in reverse order.

St. 2.1.30.01.1 TAKING BRAKE ANCHOR PLATE OUTER FLANGE DOWN; GREASING NEEDLE BEARING OF OUTER FLANGE

This operation is preceded by those mentionned in Op. 2.1.30.01.0.

- Undo connection between brake cylinder and brake hose. Put before, under the wheel, a tray to collect brake fluid which eventually would flow out from the hose.
- Unscrew bolts fastening brake anchor plate and outer flange on the steering knukle (see fig.2.10). Remove brake anchor plate.
- Draw out axially, from the axle shaft, the outer flange in which is pressed the needle bearing.
- Wash outer flange 2 - 3 times in white-spirit, each time fresh, in order to remove completelly the old grease.
- Put in the needle bearing fresh grease up to the rollers top.
- Check on this occasion the oil seal condition and replace it if there are faults upon the sealing edge. The operation should be performed with special care

concerning its accuracy, as far as the needle bearing is open.
Refitting should be performed in reverse order.

- After refitting performe the brake system bleeding, according to Op. 2.0.35.02.0 indications.

2.2. MECHANICAL MAINTENACE

Mechanical maintenance consists in periodical inspection of various assemblies of the car and changing in due time the worn-out parts and those which are important for car operation safety. The mechanical maintenance has the same periodicity as the lubrication operations. So both of them sould be performed in the same time. The car maintenace should be performed according to coded operations.

2.2.1. ARO L-25 ENGINE MAINTENANCE

OP. 2.0.01.06.0 CLEANING OIL FILTER

Filter element cleaning is performed on occasion of oil changing in the engine bath - namely, once on every second oil changing.
The operation is performed on the ground,with access under the engine bonnet, after having put a tray under the oil filter area
Unscrew oil filter center shaft (see fig. 2.15 - indicated by arrow), and remove filter box and filter element.

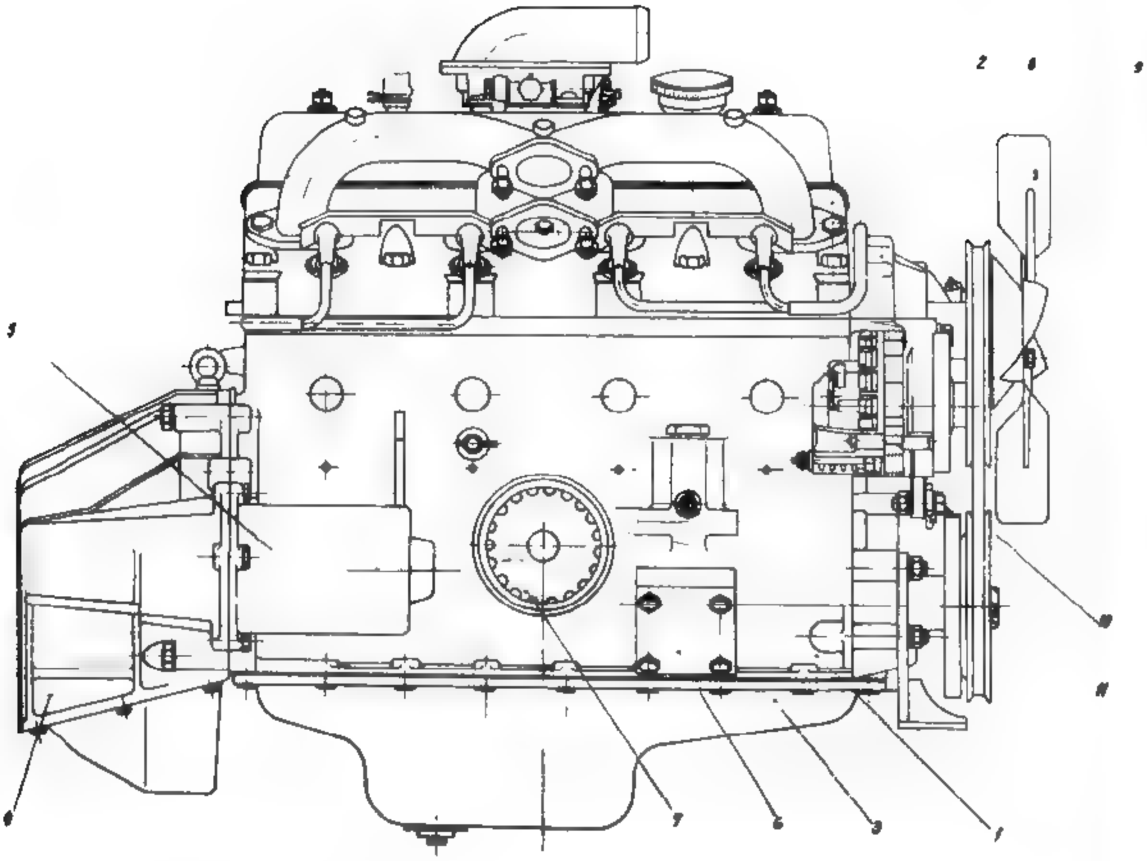


Fig. 2.14. ARO L-25 ENGINE

1. Cylinder block; 2. Cylinder head; 3. Oil bath; 4. Clutch housing; 5. Starting motor; 6. Oil pump; 7. Oil filter; 8. Water pump; 9. Cooling fan; 10. Alternator; 11. Timing gear cover.

- After having taken all necessary countermeasures against fire, wash filter element and filter box, 2 - 3 times, in fresh solvent (white-spirit) or gasoline).

  In case that box gasket is deformed, or damaged (has fissures, pinches, etc) change it with a new, original one.

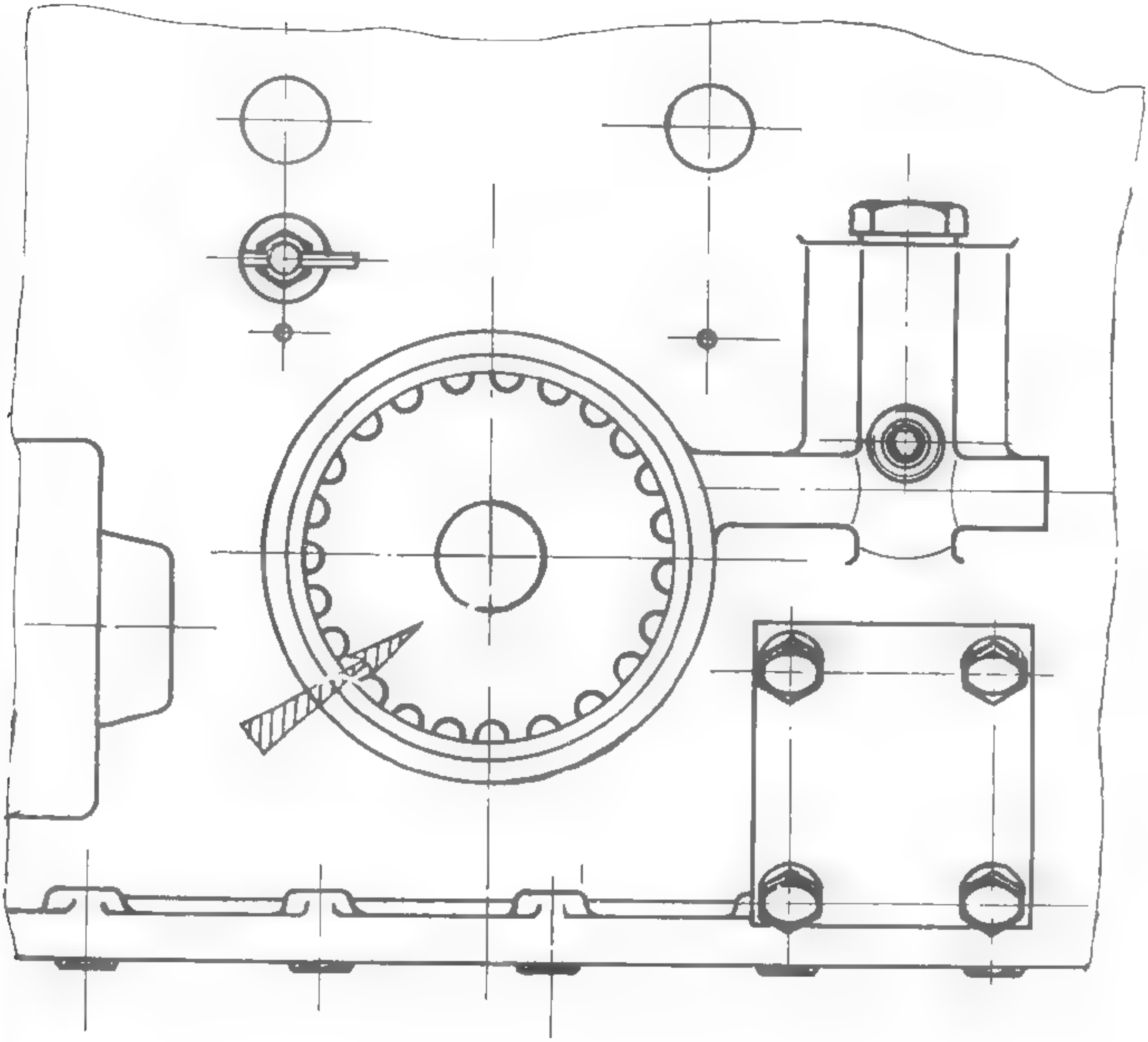


Fig.2.15. ARO L-25 ENGINE OIL FILTER
(indicated by arrow)

Refit oil filter in reverse order.

The filter center shaft should be tightened with a torque of 2.5 - 3.5 daN.m.

OP. 2.0.01.07.0 CHECKING, EVENTUALLY ADJUSTING SPARKING PLUGS

- After having removed ignition wire set, clean area around the spraking plugs with a jet of compressed air or by means of a rough brush.
- Unscrew sparking plugs using only the special spark plug wrench existing in the tool outfit of the car. In case that the sparking plugs have no faults which require their replacing by new plugs (fissured insulation, loosened insulation in metal fiting or melted ignition pin), clean the plug working end by means of a wire brush and adjust the spark gap.

  Normally, on dismantling, the working end of sparking plugs must be clean, dry and the spark gap of 0.7 mm.
- Check spark gap by means of the feeler gauge. If the gap does not correspond, reduce the spark gap up to 0.7 mm, by bending the outer mass electrode.
- On refitting sparking plugs avoid a too great difference of temperature, between engine and sparking plugs (the engine hot and the plugs cold).

OP. 2.1.01.08.0 CHECKING, EVENTUALLY ADJUSTING ROCKER ARMS

To have access to rocker arms it is preliminary necessary to take the cylinder head cover down. Operation could be performed on cold or warm engine, because the clearance between rocker arms and valves is the same, i.e. 0.45 mm.

St. 2.0.01.21.1 TAKING DOWN CYLINDER HEAD COVER

- Undo the connection between air cleaner and cover connecting socket.
- Unscrew the hemispherical nut from the cylinder head coverand remove then the flat washer and rubber gaskets.

- Remove cover from stud bolts, payng attention to not damage cylinder head cover gasket. Dismantled parts should be sheltered from impurities.
- On refitting the cover performe all operations in reverse order.
- Tighten the two nuts with a torque of 2,5 - 3.5 daN.m.

St. 2.1.01.08.2 ADJUSTING CLEARANCE BETWEEN VALVES AND ROCKER ARMS

This operation is performed after removing cylinder head cover, according to Op. 2.0.01.21.1.

A well determined clearance between valves and rocker arms has a great importance for correct engine operation.

- Crank the engine, by means of the starting handle, two or three turns to rid the tappets, push rods and adjusting screws of superfluous oil.
- Turn still the crankshaft, following this time with attention untill the mark "0" on damper of crankshaft pulley falls in line with timing pointer (see fig. 2.16) and the valve No.1 (counted from the front of the car) is in opened position (descended).

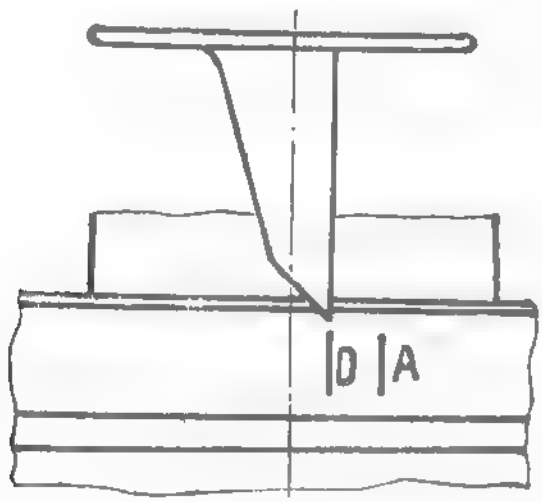


Fig.2.16. CORRECT CRANKSHAFT POSITION AGAINST THE TIMING POINTER, ON ADJUSTING VALVE CLEARANCES.

In this situation No. 4 piston nears end of compression stroke and the clearance of valves I. 4, I. 2, E. 3 and E. 4 (I- inlet, E- exhaust valve), respectively, in numbering order, the valves 3, 5, 7 and 8, should be 0.45. mm.

- The clearance is checked by means of the feelre gauge, introducing between the valve shaft the blade of 0,45 or the adjacent one.
- Turn again the crankshaft with 360^{o} more, untill the mark "0" falls again in line with timing pointer.
- In this position check the clearance of valves I. 1, I. 3, E. 1 and E. 2, respectively the valves nr. 1, 2, 4 and 6.
- In case that the clearance of some valves does not correspond with indicated value, perform consectuively clearance adjusting, as followe:
- Slacken special nut/locking the adjusting screw (1) and by means of a screwdriver turn adjusting screw till required 0.45 mm clearance is obtained (see fig. 2. 17). The clearance should be measured with a feeler gauge.
- Lock adjusting screw by tightening special nut (2).
- After locking nut check clearance anew.

OP 2.0.01.09.0 CHECKING, EVENTUALLY ADJUSTING IGNITION DISTRIBUTOR BREAKER POINTS GAP

- Remove distributor cap, together with ignition wires, distributor rotor and vacuum connecting tube.
- Rotate slowly the crankshaft, by means of starting handle, untill the insulated breaker arm heel reaches a top of the breaker cam. Now we have the maximal gap between breaker points.
- In this position the gap should be comprised between 0.35 and 0.45 mm, If not, slacken screw (4) fastening timing clamp (1) and adjust its position, untill the points gap reaches the above mentionned value. Check gap by means of feeler gauge blades (see fig. 2. 18).

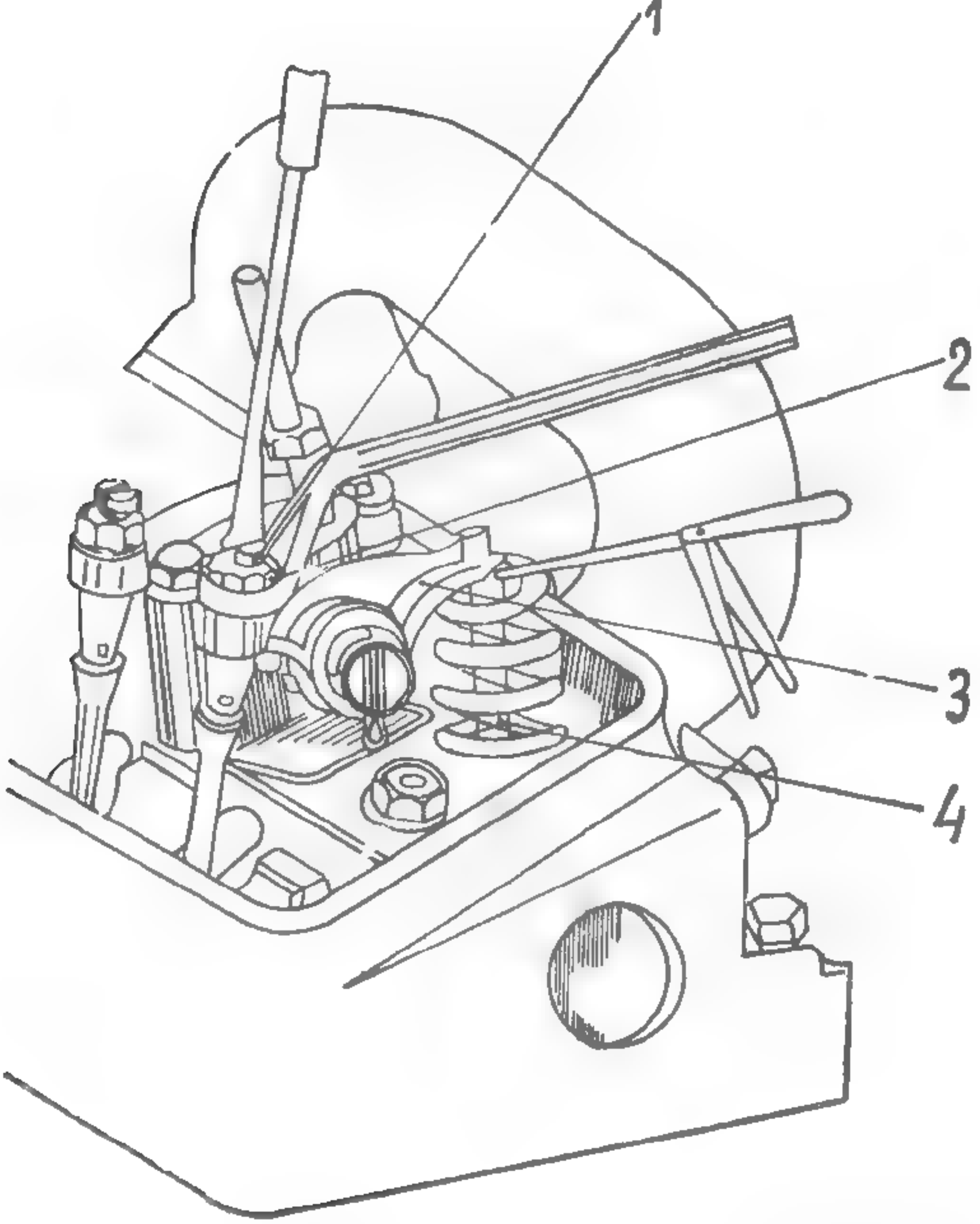


Fig. 2.17. ADJUSTING CLEARANCE BETWEEN VALVES AND ROCKER ARMS.

1. Clearance adjusting screw; 2. Screw locking nut; 3. Rocker arm; 4. Valve shaft.

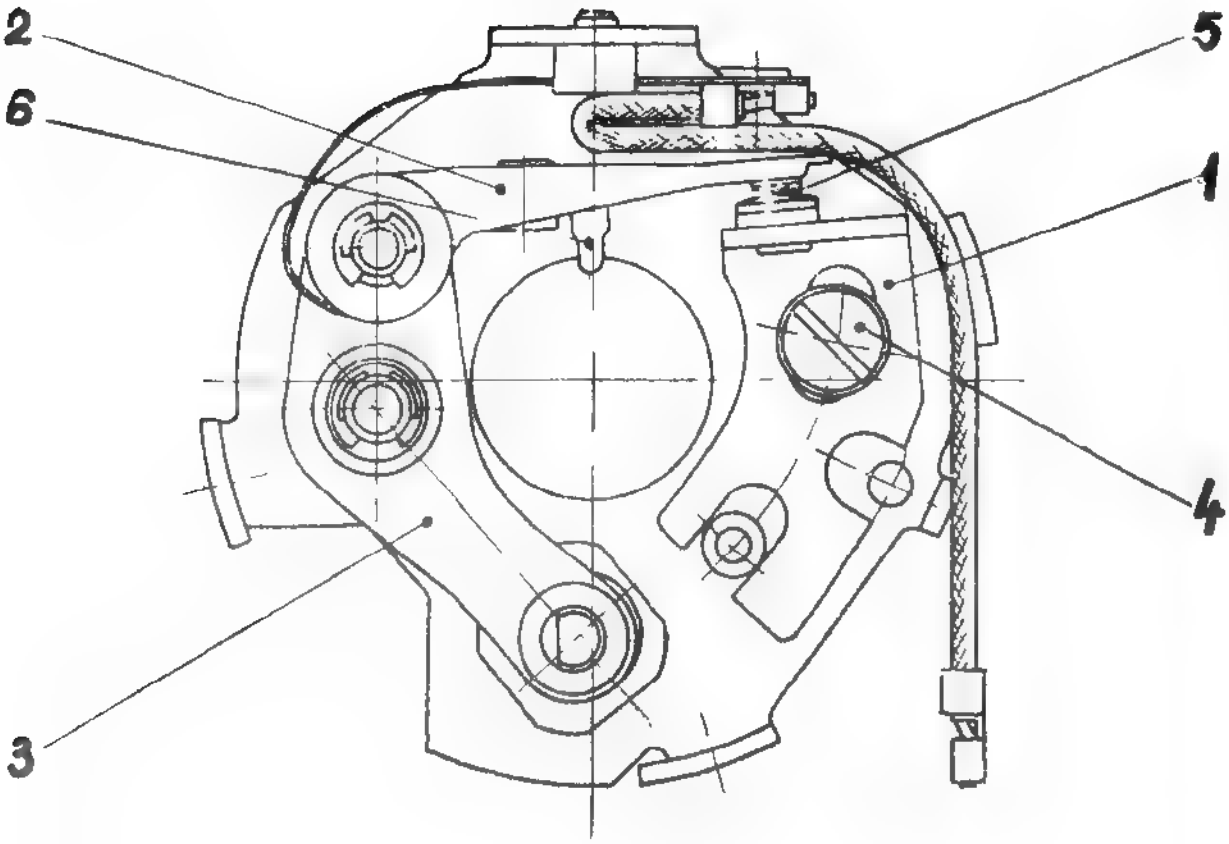


Fig.2.18. IGNITION BREAKER MECHANISM.

1. Fixed point plate; 2. Breaker point arm; 3. Adjusting mobile plate; 4. Adjusting screw; 5. Ignition breaker points; 6. Breaker arm heel.

- Retighten screw (4) of timing clamp, in order to lock it.

  Refitting is performed in reverse order.

- Check finaly if ignition wires are correctly connected in the distributor cap.

OP. 2.0.01.10.0 CHECKING, EVENTUALLY CORRECT STRETCHING OF THE FAN V-BELT

- After a mileage of about 6.000 km, before starting for a new journey, lift engine bonnet and check fan V-belt tension (see fig.2.19). The belt may be considered rightly stretched, when on being depressed with a 3 - 4 kg force,

between alternator and water pump pulley (1 and 2 - fig. 2.19), its dip does not exceed 10 - 15 mm.

- If the dip is greater, loosen the bolts fastening the alternator and by deplacing outwards, by means of a tyre lever, the alternator, try to obtain correct dip. In this position tighten the bolts fastening the alternator.

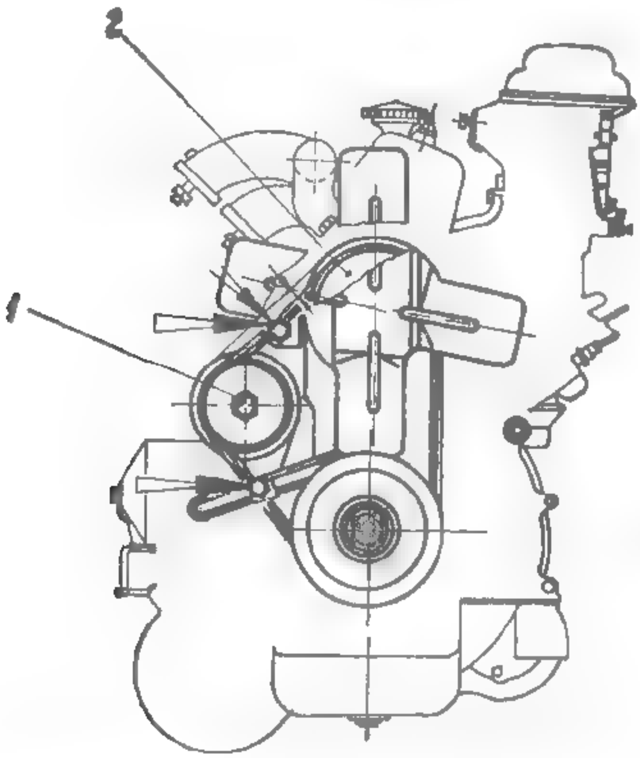


Fig. 2.19. ADJUSTING THE FAN V-BELT STRETCHING
1. Alternator pulley; 2. Water pump pulley.

OP. 2.0.01.11.0 CHANGING OIL FILTERING ELEMENT

- The operation is the same as that for cleaning oil filter (see op. 2.0.01.06.0), with the difference that the filtering element is no more washed but replaced by a new, original one.

OP. 2.0.01.12.0 CLEANING FUEL PUMP FILTERING ELEMENT

- Unscrew bolt (2), fastening filter cover (3) (see fig. 2.20), and remove successively: pump filter cover, sealing gasket and filtering strainer (3).
- Clean filtering strainer from impurities, by washing it 2-3 times in clean gasoline (pay special attention for avoidning fire danger).

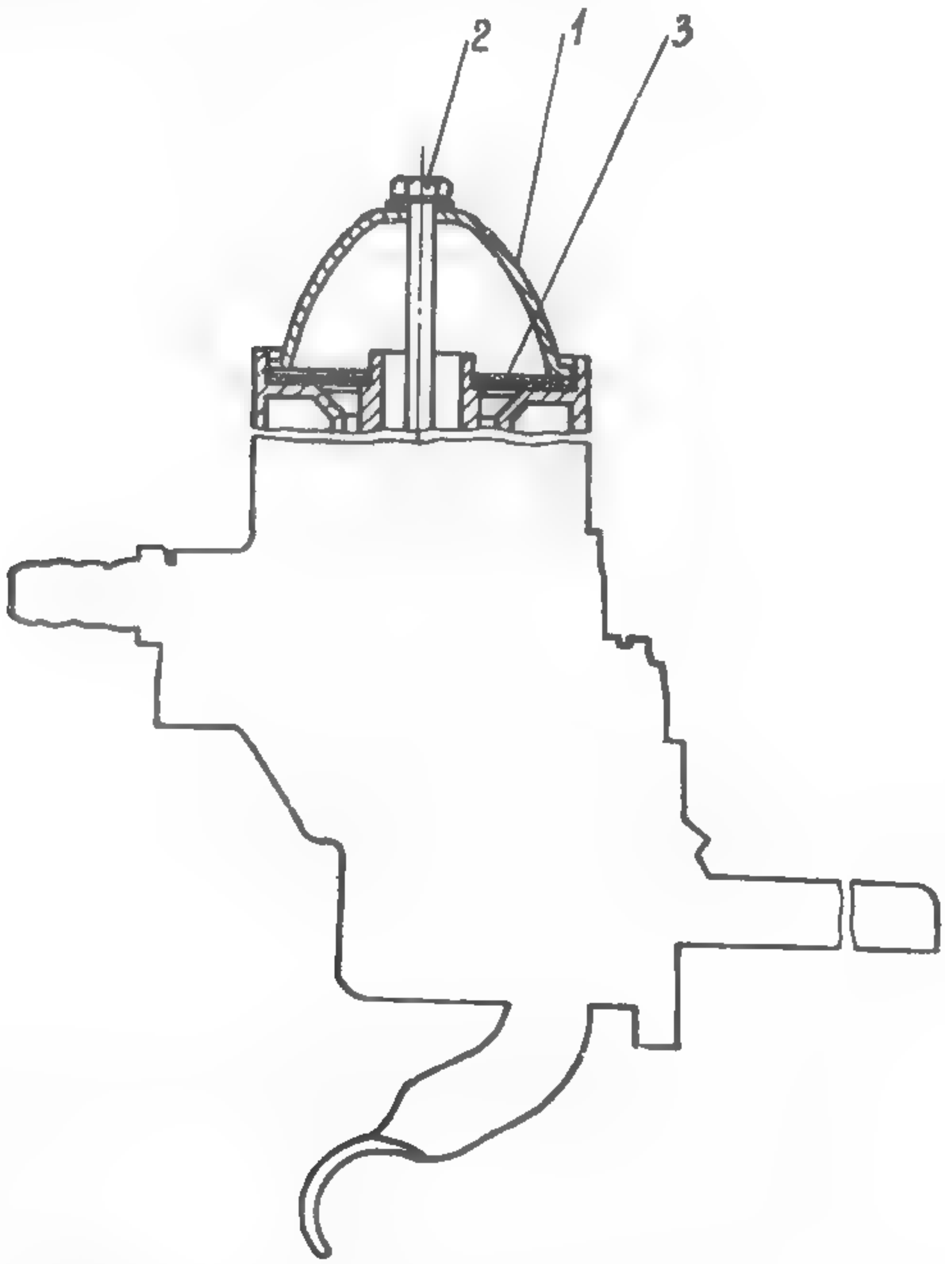


Fig. 2.20. FUEL PUMP
1. Fuel pump strainer cover; 2. Cover fastening bolt; 3. Fuel filtering strainer.

- Dry filtering strainer by blasting it with compressed air.
- Finaly inspect it against light for eventualy impurities.
- Refit all in reverse order.

OP. 2.0.01.13.0 CHECKING AND EVENTUALLY ADJUSTING IGNITION DISTRIBUTOR OCTANE SELECTOR

- Check and adjust octane selector when engine is running at a speed of about 1.600 r.p.m. and when vacuum controlled advance is disconnected.
  The measured value, by means of electronical testing equipment, should be $16...18^0$.
  Disconnecting of vacuum controlled advance is carried out by removing connecting hose from distributor vacuum control unit.
- In case that the indicated value can not be found, loosen flange for adjusting angular position of ignition distributor and rotate distributor, observing in the same time, by means of a stroboscope, the mark "A" on damper of crankshaft pulley (see fig. 2.21) untill it falls in line with timing pointer.

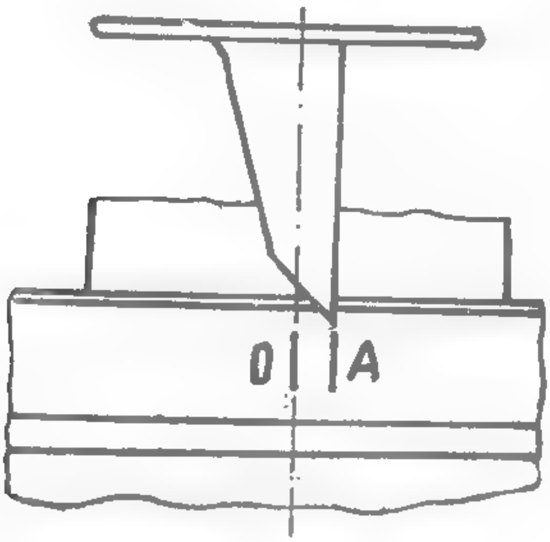


Fig. 2.21. ADJUSTING IGNITION TIMING BY ARO L-25 ENGINE

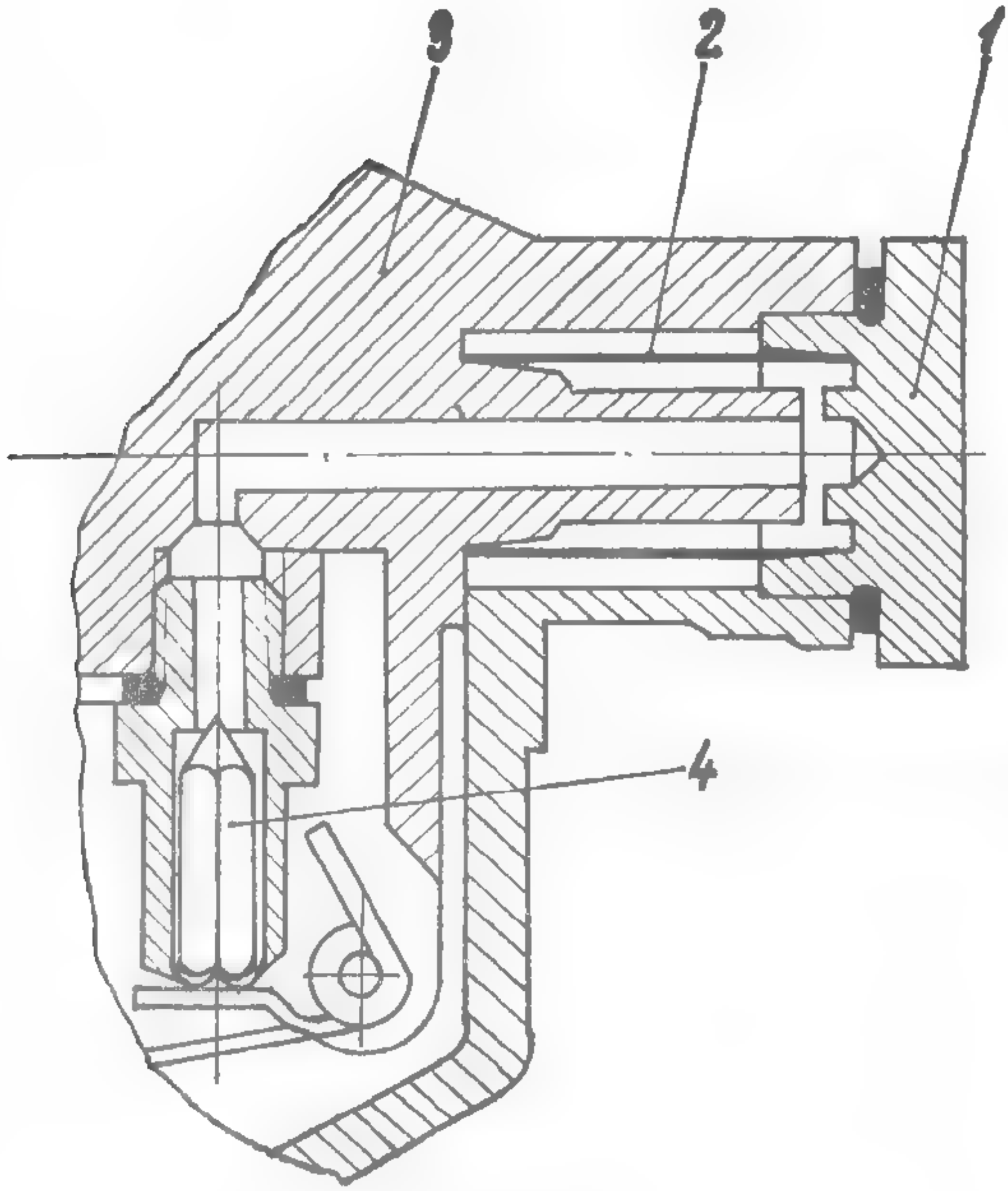


Fig.2.22. CARBURETTOR INLET STRAINER

1. Strainer plug with its gasket; 2. Cylindrical gauze strainer; 3. Carburettor body; 4. Float needle.

- In so adjusted position tighten the screw fastening the distributor flange and refin connection with vacuum control unit.

OP. 2.0.01.14.0 CLEANING CARBURETTOR INLET FILTER (STRAINER)

- Remove the plug near the carburettor feeding pipe.
- Carefully remove the cylindrical gauze strainer, checking in the same time if gasket or strainer are not deformed of fissured and it the sealing surface has no blows (see fig. 2.22).
- Wash filter strain 2 - 3 times in clean, fresh gasoline (pay special attention for avoiding fire danger).
- Check against the light if in the screen meshes are still fixed impurities.
- Performe refitting in reverse order according special attention for fitting strain, protecting bush and sealing gasket, in order to avoid deforming of respective components.

OP. 2.0.01.15.0 CLEANING CARBURETTOR JETS

For cleaning carburettor main and idle jets it should be removed air connection elbow (adapter), which is connected with air cleaner. So you will get access to the main and idle jets, (1) and (2) - fig. 2.23.

St. 2.0.01.15.1 DISMANTLING AIR CONNECTION ELBOW OF CARBURETTOR

- Unscrew nuts fastening the air connection elbow on carburettor.
- Remove the elbow together with air connecting hose, to get access to the jets area.
- Pay special attention for performing this operation with the most accuracy, because penetrating of solid impurities into carburettor, respectively into mixing chamber can lead to heavy damages of carburettor or of engine itself.

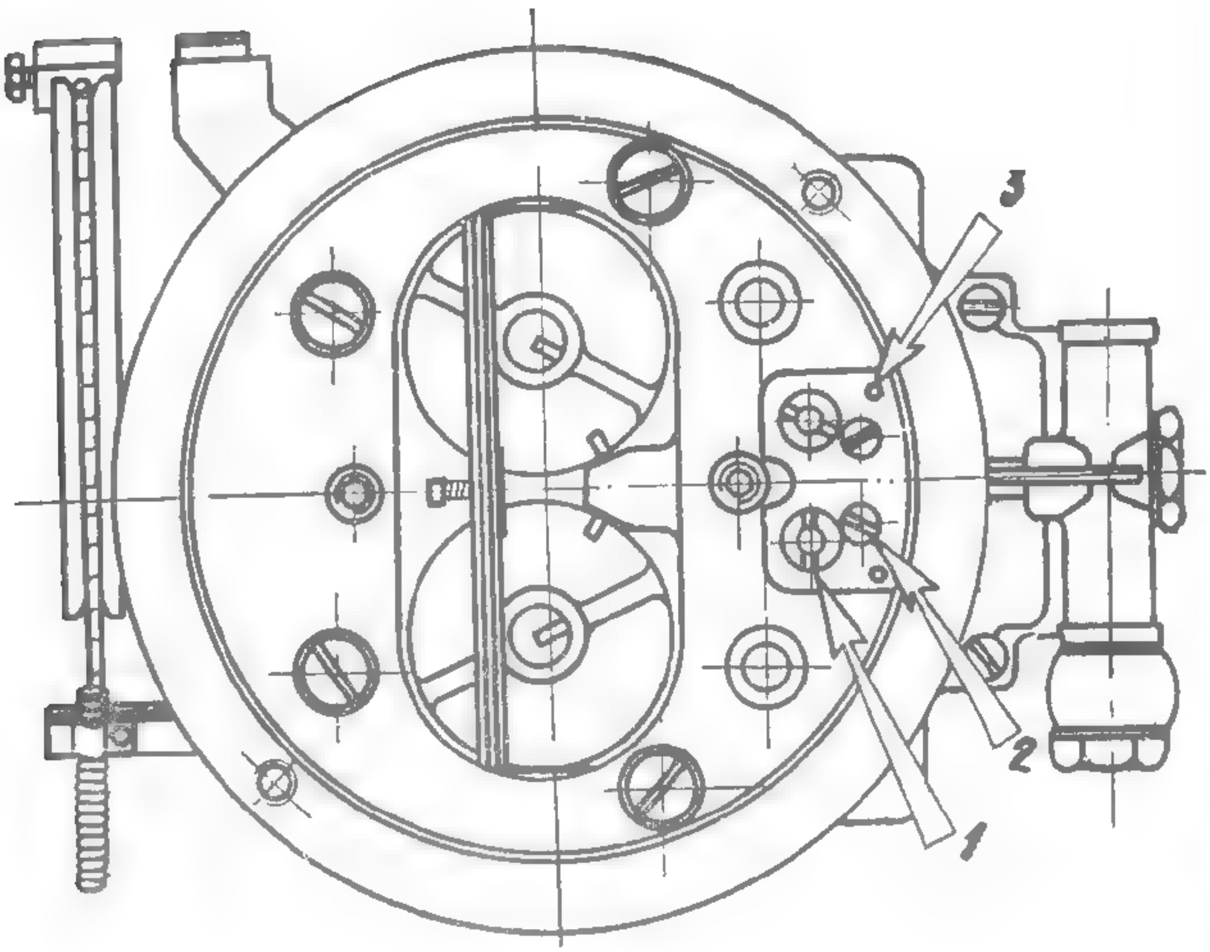


Fig. 2.23. ACCESS TO CARBURETTOR JETS

1. Main jet; 2. Idle jet; 3. Idle speed air bleed.

- Perform refitting in reverse order.

St. 2.0.01.15.2 MAINTENCE OF JETS

Under the air connection elbow, in the feeding socket area, there are the two main and the two idle jets. (see fig. 2.23).

- Unscrew with attention all four jets, without forcing them, and clean them by washing, 2 - 3 times in fresh gasoline. Pay special attention for the counter measures against fire danger!

- Dry jets by blasting with compressed air.

  WARNING: In case of a correct maintenance the jets have practically an unlimited endurance!
- If impurities cannot be removed by washing and air blasting, use soft wooden small sticks, of suitable shape.

  WARNING! Do not use any other materials, which will cause jet decalibration, with utmost unfavourable consequences concerining the engine operation and fuel consumption, needing finaly their replacement.
- Refitting is performed in reverse order.

OP. 2.0.01.16.0 WASHING CYLINDER HEAD COVER FILTER

- For this it is necessary to remove cylinder head cover, according to 2.0.01.21.1.
- Wash cover inside with gasoline or white-spirit, taking firstly all countermeasures against fire danger.
- Remove wires fastening the wire net filter the oil filler and remove the filter.
- Wash filter 2-3 times in fresh gasoline, in order to remove completely all impurities,
- Refit filter in the cover oil filter, fastening it with wires at its ends, in order to not let it get out accidentally.

OP. 2.0.01.17.0 CHECKING CYLINDER HEAD FASTENING

This operation is to be performed when the engine cold, concomitantly with washing of cylinder head cover filter, when the cover is removed and you have access to the bolts fastening cylinder head.

- Firstly check tightening of the 10 bolts, by means of a torque wrench in the sequence recomended in fig.2.24, at a torque of 7.4 daN.m. (see fig.2.24).
- Repeat the checking at a torque of 12 - 13 daN.m (kg).

- In case that some bolts have been found loosen at this torque, mark them for next inspection and then tighten them at the indicated torque.

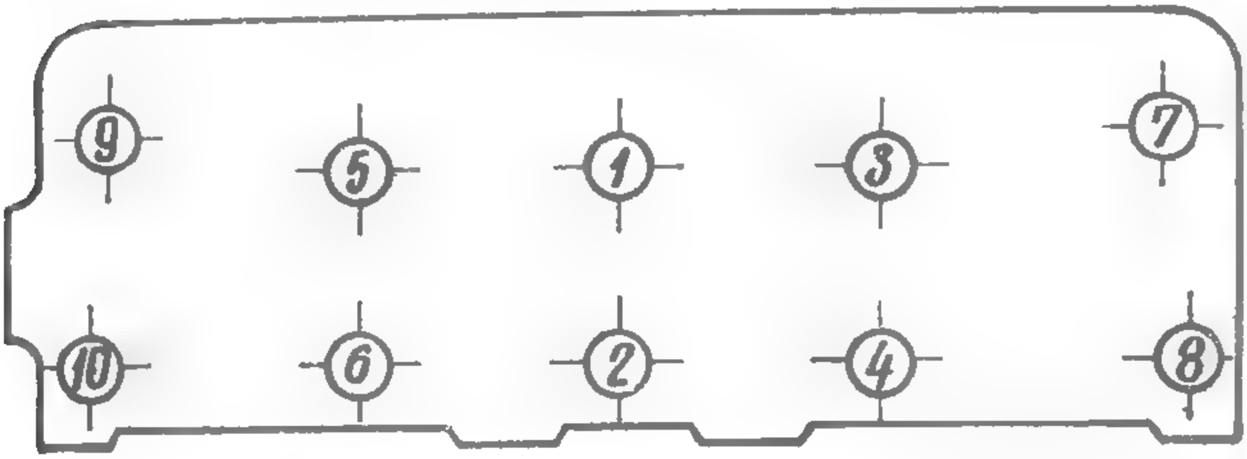


Fig. 2.24. CYLINDER HEAD BOLTS FASTENING ORDER.

- Replace the cylinder head cover, in accordance with Op. 2.0.01.21.1, start the engine and let it run half an hour at a low speed (about 1,200 r.p.m.).
- When the engine got warm, remove again the cylinder head ccover and repeat the tightening at a torque of 12-13 daN.m. - this time with the engine warm.
- Reassemble the cylinder head cover.

  In case that on a new checking the same bolt is found loosen - a little probable situation - it means that this bolt suffered the steel flow phenomenon and must be replaced with a new bolt.

OP. 2.0.01.18.0 CHECKING IGNITION WIRE SET OF ENGINE

- Remove ignition wires from distributor and check their terminals condition. If they have impurities or traces of oxidation, clean them with fine emery paper.
- Refit ignition wires on distributor, taking care for ignition order.

OP. 2.0.01.19.0 REPLACING SPARKING PLUGS

- Perform necessary operations as described in Op. 2.0.01.07.0, with the only difference that the replaced sparking plugs should have the same thermal value.

OP. 2.0.01.20.0 CHECKING ALTERNATOR

- The operation should be performed <u>when engine is stoped.</u>
  It is not allowed any intervention on alternator or on its connections with the engine electric equipment, when engine runs, because it can damage the alternator.
- Check condition of all connections, which should be stiff and without oxidations. In contrary case, remove them and clean them slightly with fine emery paper, up to clean metal. Then refit them.
- Dismantle brush-holder assy, and clean it from powder, by means of a rough brash. The wear limit of brushes is 6 mm. and when this size is reached, replace brushes.
- Refit brush-holder assy on alternator.

OP. 1.0.01.22 ADJUSTING CARBURETTOR FOR INDLING SPEED

This operation can be carried out by means of an electronic testing equipment or by a skiller worker having sufficient experience.
The adjusting is performed when engine is in its normal thermical operation, and when accelerator pedal is free.

- Operating the butterfly adjusting screw (1) (see fig.2.25), adjust engine speed at about 750 r.p.m.
- Screw completely the R.H. idle mixture adjusting screw (2) and then unscrew it 1- 25 turns.
- Repeat the same operation with the L.H. idle mixture adjusting screw

Unscrewing of both adjusting screws is performed between the two indicated limits untill an uniform running of engine is obtained.

- After that, operate again the butterfly adjusting screw (1), untill the engine speed of 750 r.p.m. is obtained.

OP. 2.0.37.04.0 CHECKING STARTING MOTOR CONNECTIONS

- Check starting motor connections which should be stiff and without impurities or any oxidation.

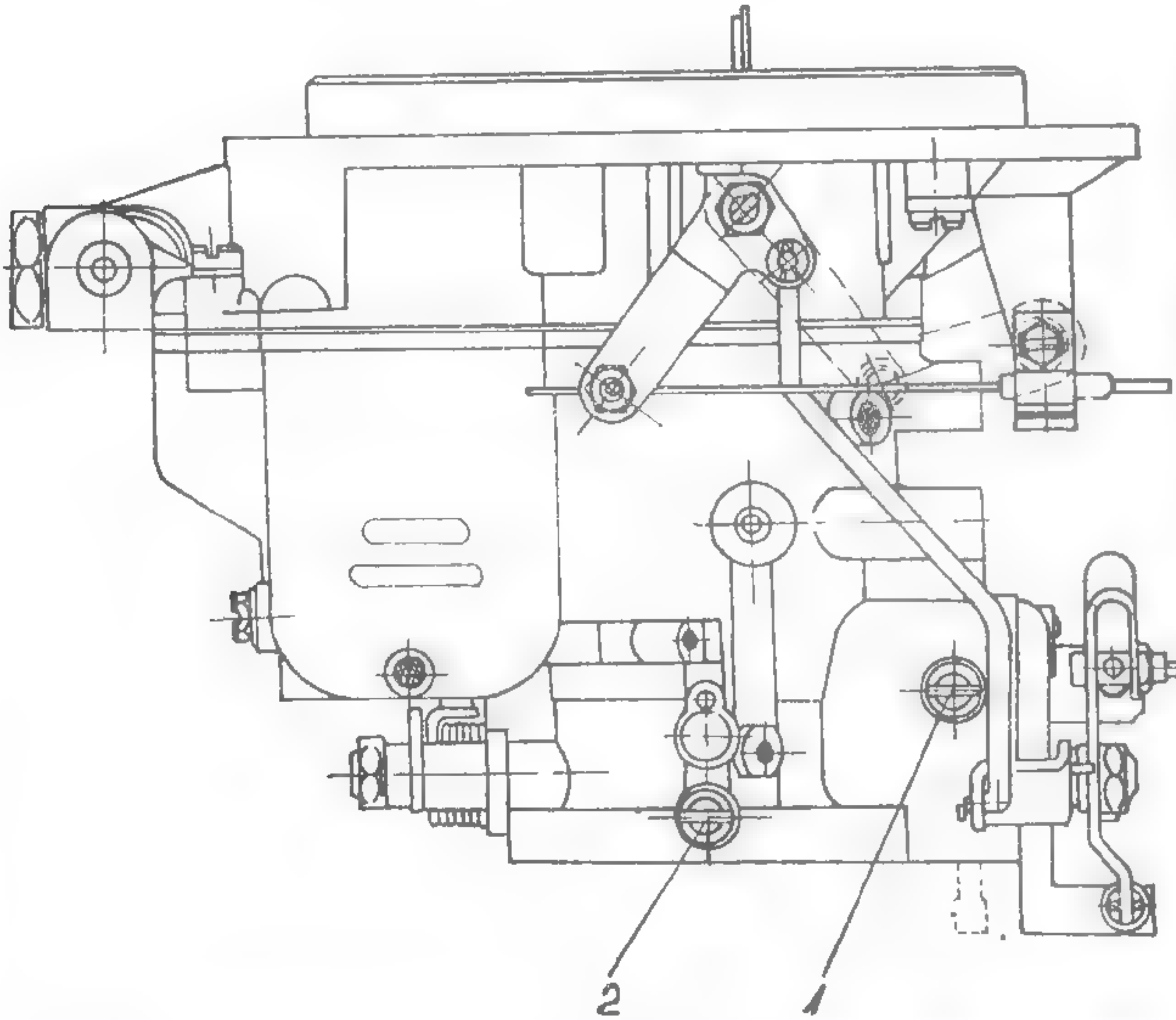


Fig. 2.25. LOCATION ON CARBURETTOR OF IDLE SPEED ADJUSTING SCREWS.
1. Butterfly adjusting screw; 2. Idle mixture adjusting screw.

- If necessary, undo connection from motor terminal and clean the components up to clean metal, using a fine emery paper.
- Refit connection, tightening well respective nut.

OP. 2.0.37.05.0 CHECKING STARTING MOTOR COMMUTATOR

- Loosen the screw of cover band and remove it.
- Remove plastic protection, in order to uncover commutator and commutator brushes area.
- Clean with a rough brush powder deposit from brushes, commutator, brush springs and connection leads.
- Check brushes for rate of wear and if their lengthn decreased under 15 mm, they should be replaced (see chapter concering starting motor repair).
- Check also wear of rate and cleanlines of commutator. If it will be strictly necessary (flame round the commutator, during operation), it is allowed a slight polishing, but only with very fine glasspaper (not emery paper).
- Blast starting motor with compressed air or clean it with a smouth brush, in order to remove powder produced by polishing commutator.
- Replace plastic protection and tighten the fastening screw.

2.2.3. S-127 DIESEL ENGINE MAINTENACE

D-127 engine maintenace is specific to middle speed Diesel engines, with rotary pump and electrical starting by means of ARO car storage battery.

OP. 2.01.04.0 D CHECKING TIGHTNESS OF JOINTS

Besides usual indications concerning checking of eventual oil or brake fluid leaks, pay special attention for high pressure fuel lines, concerning the joints on fuel pump and fuel injections.

- If you will find the joint adjacent areas got wet with fuel, replace absolutely the fauliy joint components.

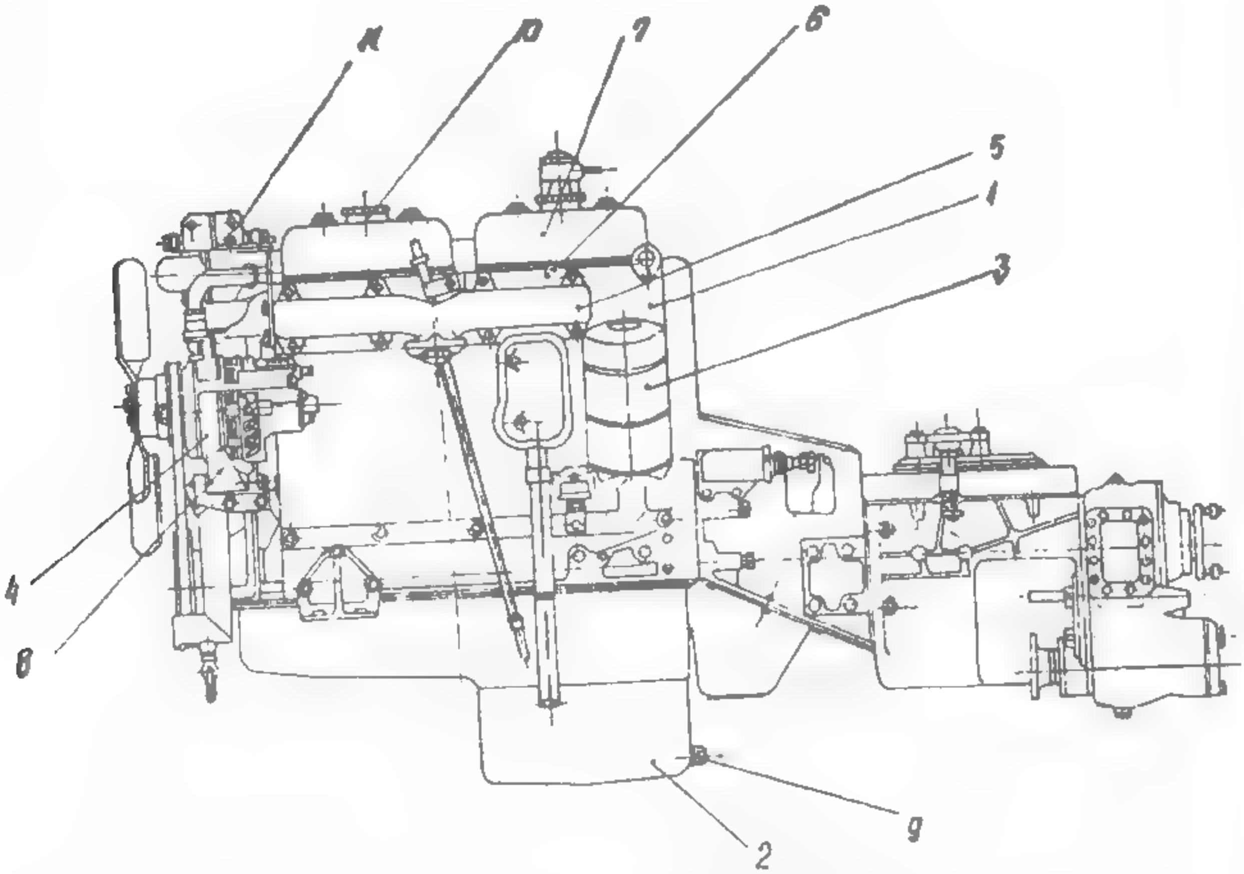


Fig. 2.26. ARO D-127 DIESEL ENGINE SIDE VIEW
1. Cylinder block; 2. Oil bath; 3. Oil filter; 4. Alternator; 5. Exhaust manifold; 6. Cylinder head; 7. Cylinder head cover; 8. Water pump; 9. Oil bath draining plug; 10. Oil filler cap; 11. Safety oil filter.

OP. 2.0.01.05.0 D CHECKING FASTENING OF D-127 ENGINE ASSEMBLIES

The Diesel engine is strongly shaking on idle speed; this can cause loosening of various assemblies fastening by means of bolts and nuts.

- Check, and if loosened, tighten:

Exhaust manifold fastening bolts;

Alternator support fastening bolts,

Clutch housing fastening bolts;

Nuts fastening gearbox on clutch housing,

Bolts fastening exhaust pipe on exhaust manifold;

Bolts fastening starting motor;

Nuts fastening injection pump.

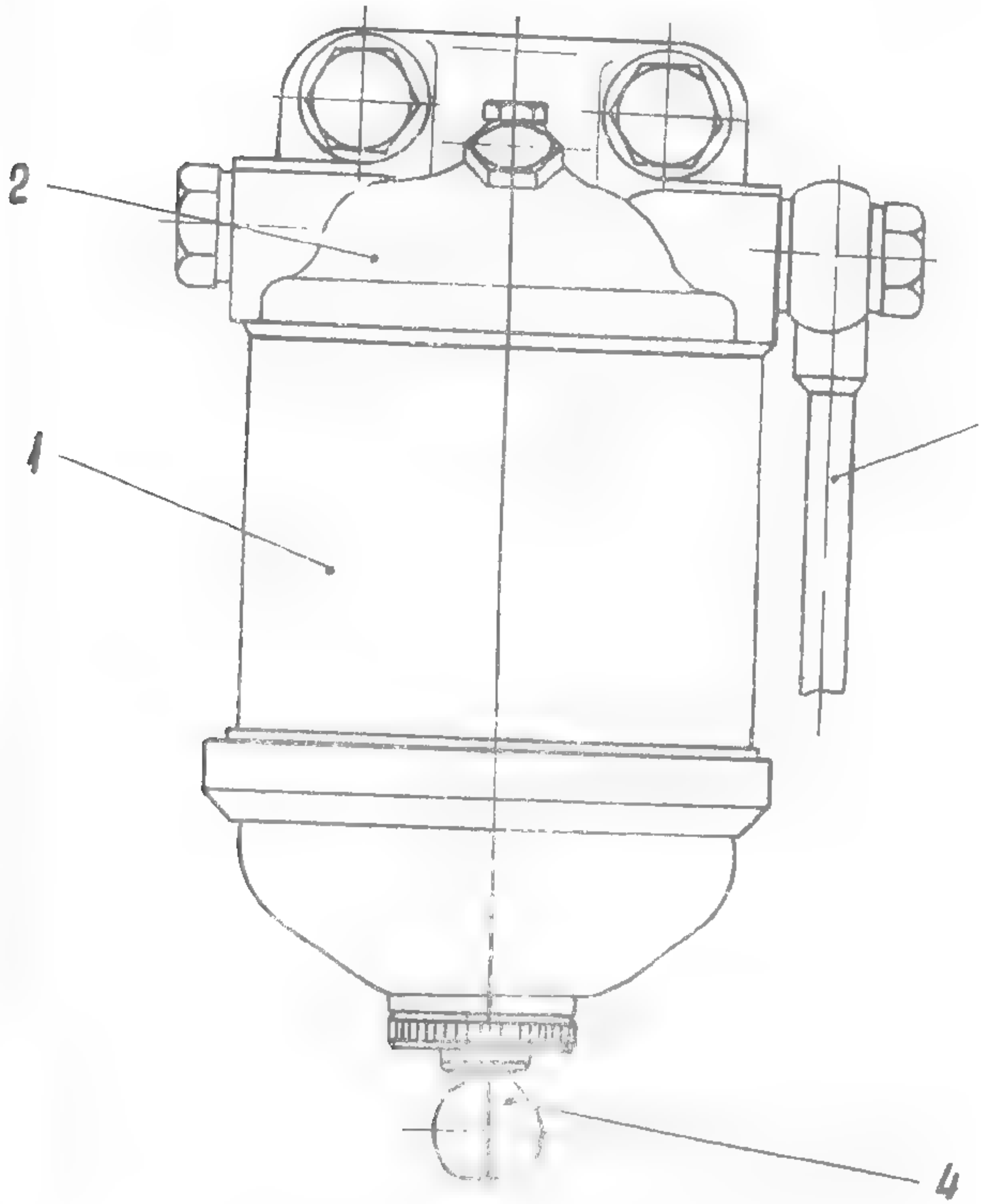


Fig. 2.27. AGGLOMERATING FILTER
1. Filter body; 2. Filter cover; 3. Feeding pipe; 4. Impurities draining plug.

OP. 2.0.01.06.0 D DRAINING FUEL FILTER SETTLING BOWL

- Place under the agglomerating filter a collecting tray.
- Loosen with 3 - 4 turns the lower filter draining plug (see fig. 2.27) and let drain water and other impurities out.
  Pay special attention for preventing fire danger!
- Tighten the plug when instead water fuel flows out.

OP. 2.0.01.07.0 CLEANING FUEL PUMP FILTER
(see fig. 2.28)

- Unscrew upper screw fastening fuel pump cover.
- Remove cover and gasket.
- Remove filtering strainer and wash it 2 - 3 times in fresh fuel, blasting it then with compressed air.
- Pay special attention for preventing fire danger.
- Check filtering strainr against light for eventual impurities, check if gasket is not damaged.
- Refit all in reverse order.
- Bleed then fuel supply system.

OP. 2.0.01.08.0 D CHECKING FAN V-BELT CORRECT TENSION

- Press the V-belt, in the area between cooling fan and alternator pulleys (in the upper engine area - see fig. 2.29), with a force of about 5 - 7 daN (kg), if the belt tension is correct the belt dip should be of 12 mm. If the dip is more then 12 mm, the V-belt should be tensioned.
- For this, slack the bolt fastening alternator in its position and tilt alternator outside, to obtain correct belt tension.

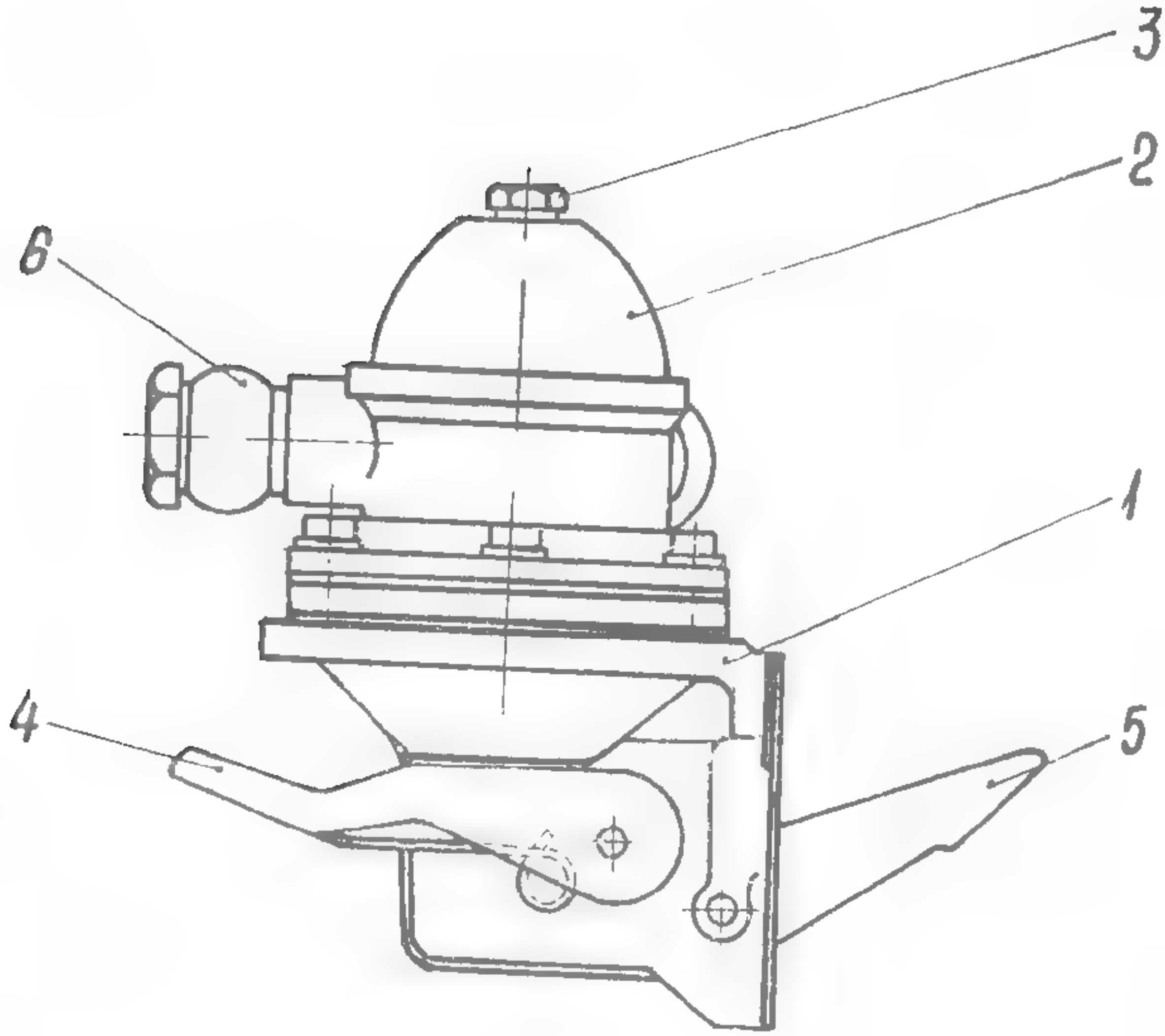


Fig. 2.28. DIESEL FUEL OIL PUMP
1. Pump housing; 2. Pump cover; 3. Bolt fastening pump cover; 4. Rocker arm for manual operation; 5. Rocker arm for mecanical operation; 6. Hose nipple.

- After a certain journey check again the belt tension, which normally maintains its correct dip. If the belt dip has increased, it means that a new belt stretching is produced and the V-belt should be replaced with a new one.

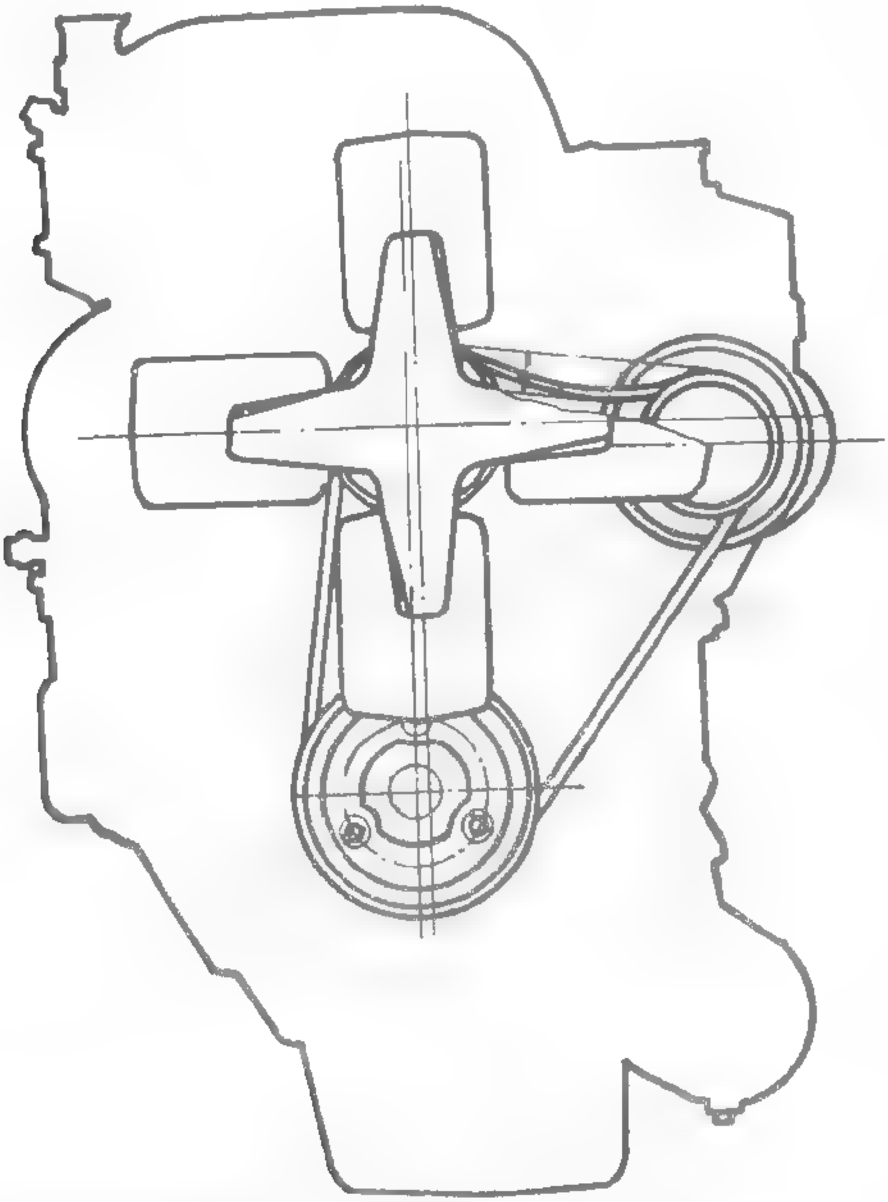


Fig. 2.29. CHECKING ELEMENT FASTENING ON D-127 ENGINE

OP. 2.0.01.09.0 D CHECKING RADIAL AND AXIAL RUNOUT OF PULLEYS

- Inspection is performed during engine running, visually.

The runout of pullerys has a great importance concerning the belt endurance. This inspection is facilitated by thé belt vibration near the pulley having a runout.

- If a pulley runout is found, take respective pulley down in order to remediate it, according the respective repair chapter.

OP. 2.0.01.10.0 D VOLTAGE REGULATOR MAINTENANCE

- Check ignition breaker points condition, but only when the engine does not run.
- Check if there are any impurities or oxides.
- If yes, undo the connections and clean the points with a fine abrasive paper.
- Refit then electrical connections, taking care to respect the leads position.

OP. 2.0.01.11.0 D STARTING MOTOR CURRENT MAINTENANCE

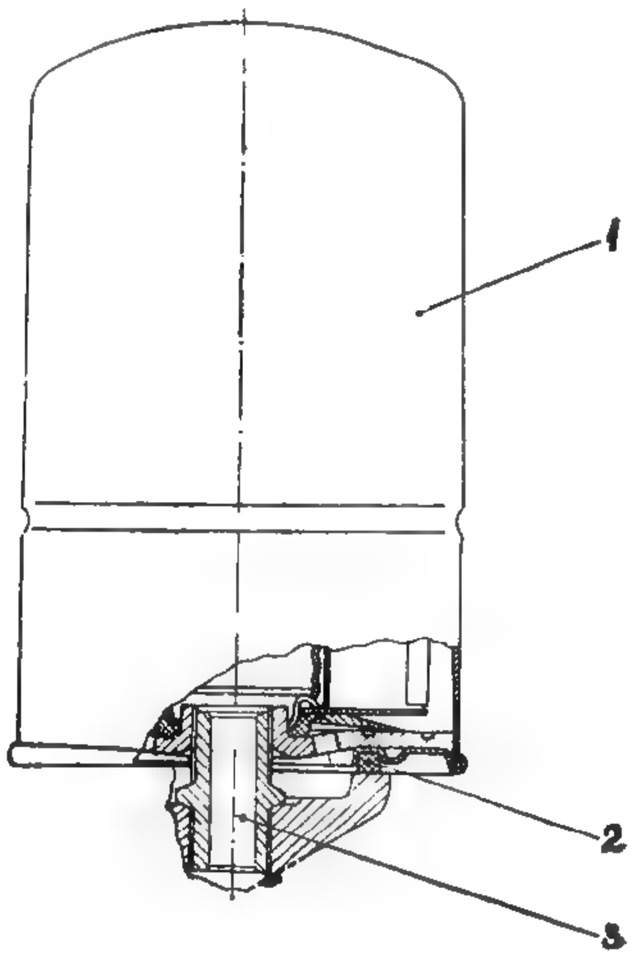
- This operation is performed similarly as described in 2.0.37.04.0 and 2.0.37.05.0.
- Check if starting motor pinion and flywheel ring gear meshing is correct. For every observed anomaly perform necessary remedying as indicated in the repair chapter.

OP. 2.0.01.12.0 D CHANGING OIL FILTERING ELEMENT

- Unscrew the filtering element from its support and replace it with a new one (see fig. 2.30).
- Pay special attention on refitting the sealing gasket.

OP. 2.0.01.13.0.D CHANGING FILTERING ELEMENT OF THE FUEL SETTLING FILTER

- Unscrew the upper bolt fastening the filtering element, remove it from the filter and replace it with a new one.
- Tighten then bolt with a torque wrench, using a torque of 0.8.-1.1 daNm(kgm). Filtering element replacing should be performed when troubles of fuel supply system appear.



2.30. OIL FILTERING ELEMENT FASTENING ON D-127 ENGINE

If after replacing filtering element of the fuel settling filter there is no improvement, performe changing of the safety filter filtering element. On this occasion check the gasket condition and replace the faulty gaskets.

- Pay special attention for operation accuracy: any impurity introduced in the fuel circuit may cause heavy trobles of the injectors operation.
- Pay special attention for preventing any fire danger.
- Finaly bleed the fuel supply system.

OP.2.0.01.14.0.D. CHECKING INJECTORS CONDITION

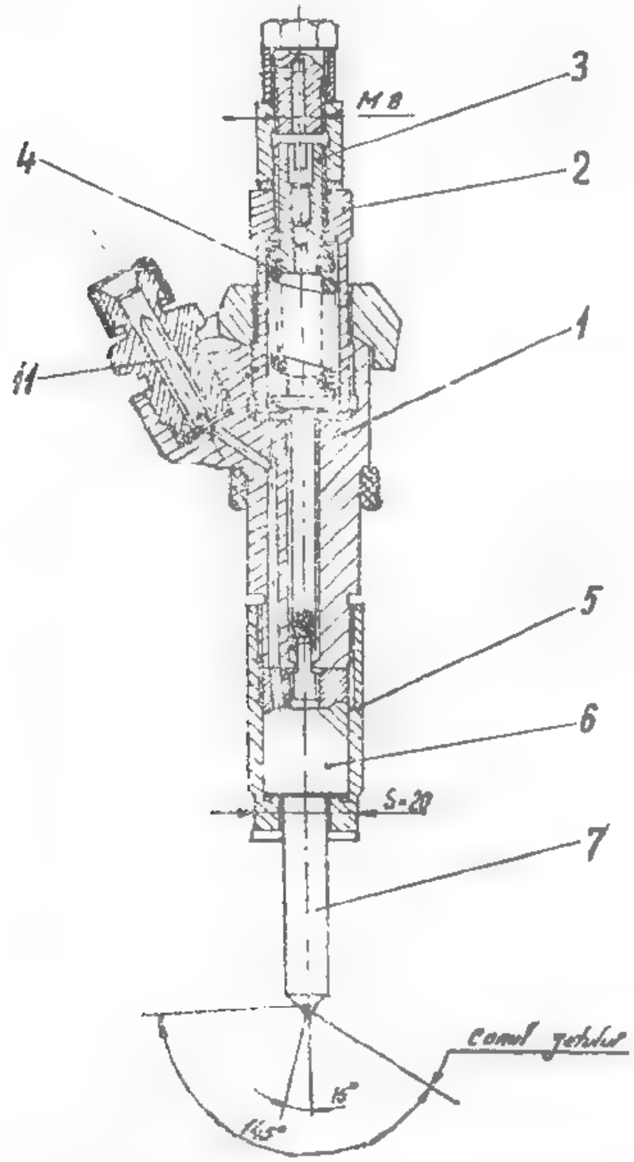
For checking injector it is necessary to take them from cylinder head down, performing the checking on the workbench and paying special attention for operation accuracy and full safety against fire danger.

St.2.0.01.14.1.D. TAKING INJECTORS FROM CYLINDER HEAD DOWN

- Disconnect the high pressure fuel pipe from injector.
- Disconnect and remove from injectors the fuel leakages collecting pipe.
  Unscrew nuts fastening the injectors on cylinder head and remove the injectors.
- Refit injectors in revrese order.
- After refitting bleed fuel supply system at injectors level.

St.4.1.01.15.0.D. CHECKING INJECTION PRESSURE AND FUEL ATOMIZING QUALITY

- The test bench should be per ectly clean, taking into account that the injectors are assembled withaa high degree of precision, with very small clearances betwenn the components and on its perfect operation is depeding engine operation, concerning the power output, fuel consumption and exhaust gases.
- Fit injector so as it was taken down from the cylinder head, on the injection pressure testing device, D-501, and perform checking by manually actuating of device.
  If automizing is not correct, dismantle and clean the atomizer.
- Remove injector cover and loosen the adjusting screw untill the injector spring becomes free.
- Unscrew atomizer nut and remove atomizer taking care the the atomizer niddle should not fall from its body out.
- Clean by means of a rough brush the crust deposit on the atomizer head.
- For softening carbon deposit crust, immerse the respective components in frash white-spirit or other organic solvent.

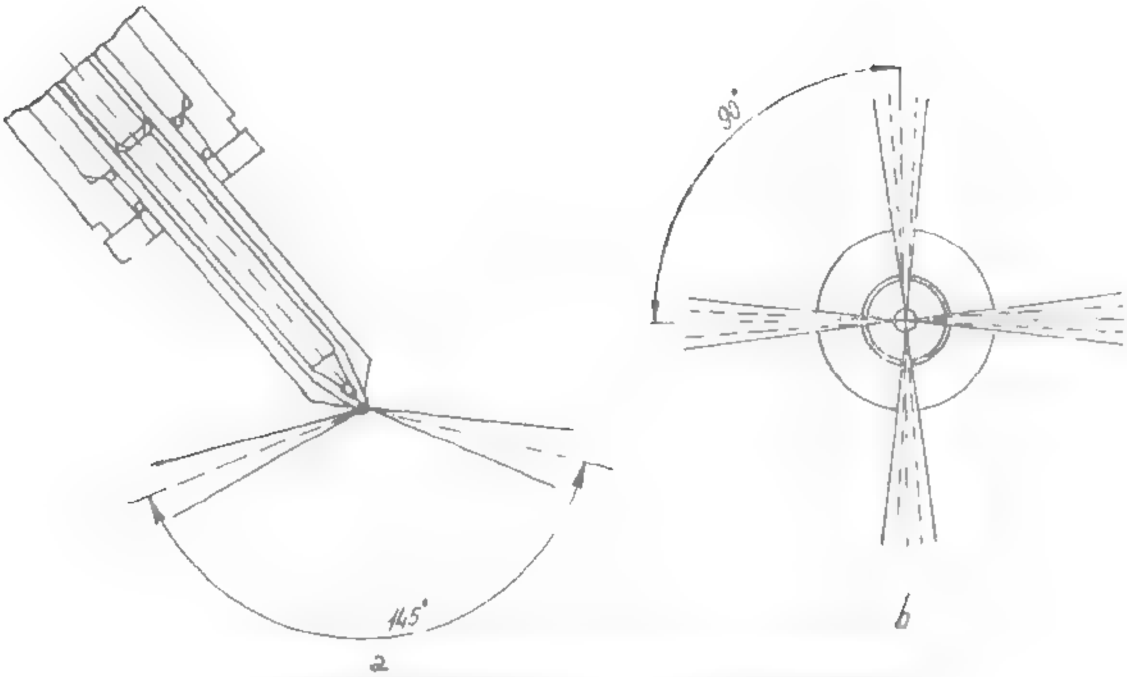


2.31. D-127. DIESEL ENGINE FUEL INJECTOR

1.-Injector cover; 2.-Injector cover; 3.-Adjusting screw; 4.-Injector adjusting spring; 5.-Atomizer nut; 6. Atomizer (spray); 7.- Atomizer needle; 8.-Injector filter.

ATTENTION ! Do not uncouple injector needles and atomizers, because they are not interchangeable !

- After first cleaning check if needle slide easily in the atomizer body.



2.32.. CORRECT ASPECT OF FUEL ATOMIZING

- The atomizer body should not have any kind of mechanic damages, nor any tinge by oxidation, due to overheating.
- For removing carbon deposit from the atomizer delivery chamber, remove the needle, and by means of the special S-501 tool clean the chamber, by rotating and pressing the point jaw upon the chamber wall.
- Clean in the same manner the cone body and the small cilindrical space on the top of the cone, using the S-502 tool (successively both the tool ends).
- Atomizing oriffices should be cleaned by means of the special A-502 drift. The needle should be out from the fastening bush for a length of 1,5 - 2 mm. A greater length facilitate the needle breaking and the needle end, remained in the oriffice, brings atomizer out of use.
- Clean needle point using the wire brush from the car tool outfit, fastening firstly the needle in the special S-502 device.
- After mechanical cleaning of neddle and atomizer, as explained above, wash the components in fresh white-spirit, 2-3 times, and blast them with compressed air.
- If it will be found that the needles are blue coulored, due to overheatings, or that the sealing surface is dull, replace the couple atomizer body-needle with a new one.

- Pay special attention for preventing fire danger !
- Perform refitting of needle in the atomizer body having both of them immersed in clean, ffresh Diesel fuel.
- Remove injector filter fit it on D-501 device and pass through the filter a fuel flow, contrary to normal flow in order to clean filter from impurities. If the filter is clogged, replace it.
- Refit injector in reverse order to that on dismantling.
- Before refitting the cover, fit injector on D-501 device and adjust the injector spring force, so t-that it opens at a pressure of 225 $\pm$ 5 bar (1 bar = 1,02 kg/cm^2).

ATTENTION: The injector maintenance should be carried out only in special workshops, havirg adequate tools and devices'equipment.

OP.2.0.01.16.0.D. CHECKING & ADJUSTING THE VALVE CLEARANCE

This operation needs preliminary taking down of calinder heads.

St.2.0.01.16.1.D. TAKING DOWN OF CYLINDER HEADS

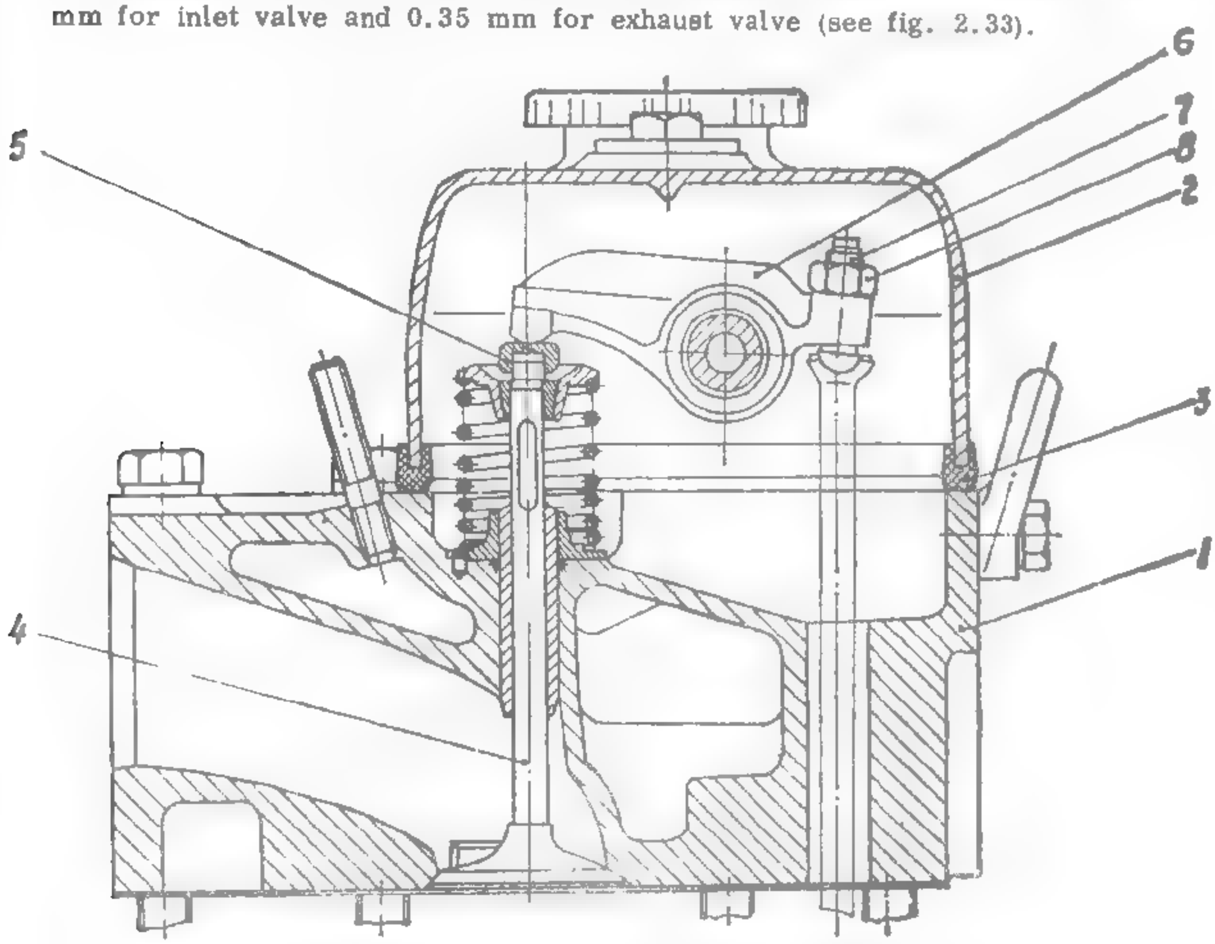
- Loosen successively special nuts, fastening the two cylinder head covers.

ATTENTION ! The special nuts, having incorporated a lock piece, can not be completely removed. So, loosen them untill they get free!

- Remove the covers with care, the sealing gasket can be sligtly adhered on sealing surface due to pressing for a long time.
- Performe this operation with much accuracy, in order to evoid penetrating of impurities into engine lubricating circuit.
- Refit cylinder head covers in reverse order paying special attention for correct fitting of gaskets betwen the covers and cylinder heads.

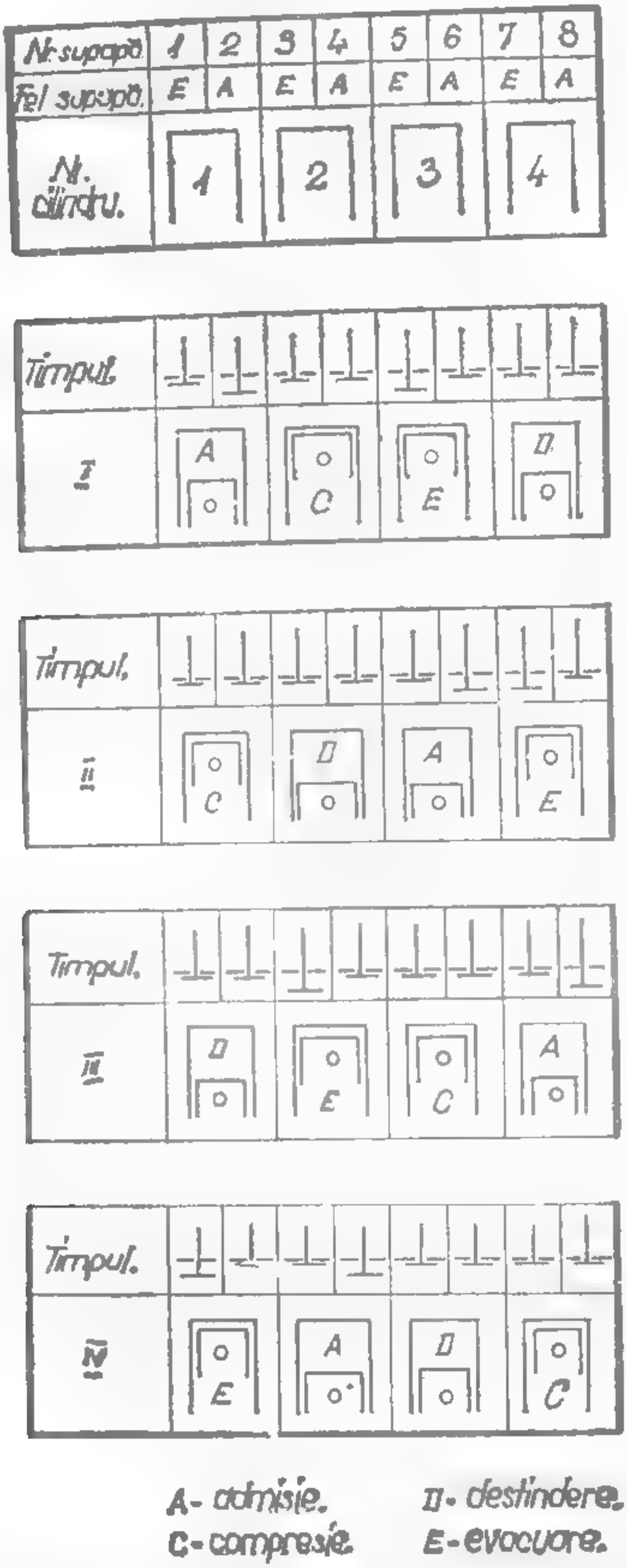
St. 2.0.01.16.2. CHECKING & ADJUSTING VALVE CLEARANCE

- After taking cylinder head covers down, performe checking the clearamce between valves and rocker arms, by means of feeler gauges. When engine is cold the clearance between the valve stem tip and and rocker arm should be of 0.25 mm for inlet valve and 0.35 mm for exhaust valve (see fig. 2.33).



2.33. CROSS SECTION OF D-127 ENGINE CYLINDER HEAD - 1.- Cylinder head body; 2.- Cylinder head cover; 3.- Cylinder head cover gasket; 4.- Inlet valve; 5.- Valve tip; 6.- Rocker arm; 7.- Valve clearance adjusting screw; 8.- Adjusting screw lock nut.

- The valve order, counting from the cooling fan (front of engine), is the following:
- The inlet valves, marked with "A" (Admisie - Inlet), are numbered 2,4,6,and 8.



2.34. DIAGRAM OF THE FOUR CYCLES BY D-127 ENGINE
Nr. supapă = Valve No, Fel supapă - Valve kind; Nr. cilindru Cylinder No; Timpul Cycle; A Inlet; C - Compression; D - Expansion; E - Exhaust.

- The exhaust valves, marked with "E" (Evacuare - Exhaust), are numbered 1, 3, 5 and 7.

  The firing order is 1 - 3 -4 - 2, so that during the four cycles the situation is such as in the Fig. 2.34.
- When engine is cold crank it several turns, in order to eleminate oil in excess between the components; crank then further until nr. 1 piston nears end of compression str   i.e. its inner dead center.
- In this position the clerances should be:

  For valves E1 and E5 - 0,35 mm clearance

  - For valves A2 and A4 - 0,25 mm clearance
- Crank now agian the engine a complete turn (360^0) ; now the nr. 1 piston rea ches again its inner dead center, this time at the end of exhaust stroke.
- In this position the clearances should be:

  For valves E3 and E7 - 0,35 mm clearance

  - For valves A6 and A8 - 0,25 mm clearance

  If you will find by some valves different clearances, performe the clearance adjusting, as follows:
- Loosen the nut, locking the adjusting screw using a socket wrench; then, by means of a screw-driver, turn the screw, untill above indicated clearance is obtained.
- Holding adjusting screw in this new position, tighten the lock nut.
- After locking the adjusting screw, crank engine 2 - 3 turns and check again the clearances, according to indicated diagram.

OP. 2.0.01.17.0.D. CHANGING FILTERING ELEMENT OF SAFETY FILTER

This operation is performed similarly as on changing filtering element of the fuel settling filter, as described in Op. 2.0.01.13.0.D.

OP. 4.0.37.06.0. ALTERNATOR COMPLETE MAINTENANCE

This operation is common for both the engine types, the alternators being indentical. To perform its complete maintenance, the alternator should be taken down from the engine.

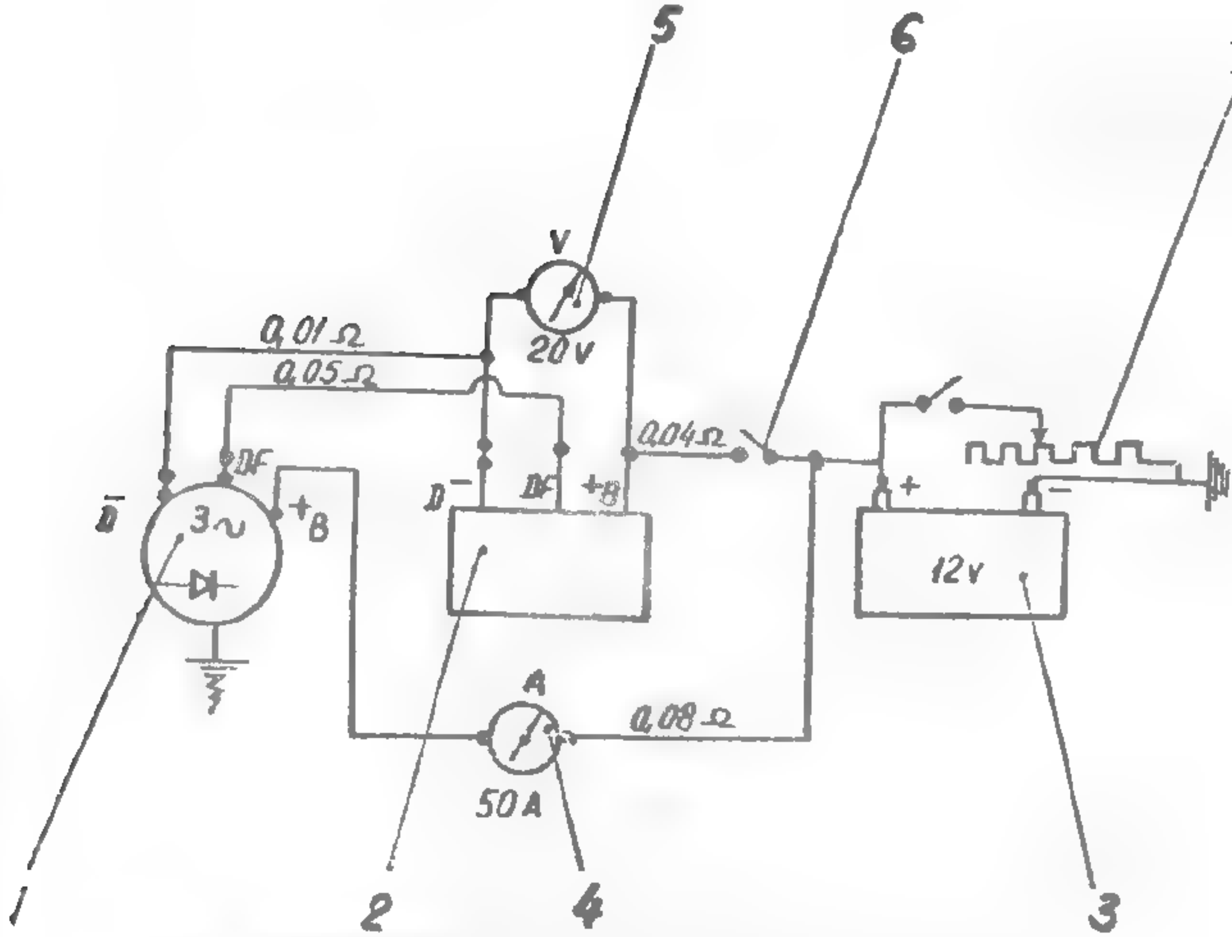
St.2.0.37.06.1. TAKING ALTERNATOR DOWN FROM THE ENGINE

- Performe alternator taking down when engine is stoped.
- Disconnect alternator from the rest of electric equipment. For this:
- Unscrew bolt fastening alternator support and tilt alternator, in order to remove the drive V-belt.
- Remove bolt from the alternator hinge eye.
- Bring alternator on the workshop bench, in order to performe its complete maintenance.
- Refitting alternator is performed in reverse order, taking care to adjust correct V-belt tension, as discribed in Op. 2.0.01.10.0 - for the ARO L-25 engine, respectively in Op. 2.0.01.08.0-D, for the ARO D-125 engine.
- Pay also attention for correct connecting of alternator, according to the wiring diagram All connecting contact surfaces should be clean, or if necessary be cleaned.

St. 4.0.37.06.2. ALTERNATOR - VOLTAGE REGULATOR TEST

- After having performed alternator current maintenance, as prescribed in Op. 2.0.01.20.0, take down voltage regulator from the car and carry out the connection test diagram, as shown in fig.2 35 Take care that electric resistance of connecting wires should not exceed the values indicated in diagram.
- By means of a load resistor adjust alternator current output from 2 Amp. to 40 Amp.

NOTE: Voltage regulator should be fastened on a metal plate, in the same position as on the car.



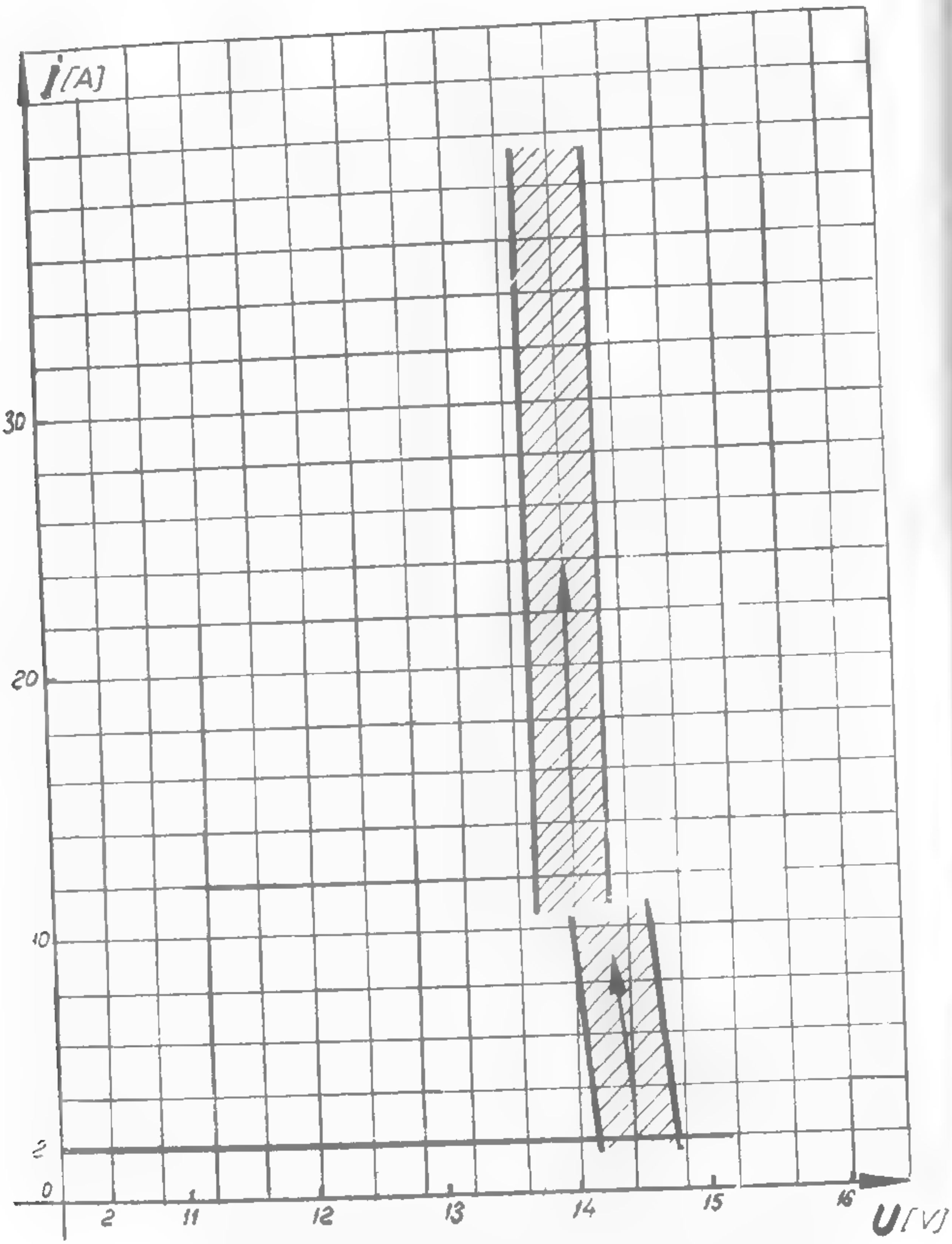
2.35. CONNECTION DIAGRAM FOR ALTERNATOR TEST ON TEST BENCH

1.- Alternator; 2.- Voltage regulator; 3.- 12 V storage battery; 4.-50 Amp.ammeter; 5.-20...25 V voltmeter; 6.- Switch; 7.- Variable resistance for 1000 W, 50 Amp.

If the available test bench is provided only wi h one constant speed for tested alternator, tray to fetch a drive transmission, which could be able to drive alternat shaft at a speed of 5,000 r.p.m.

- Maintain the alternator speed at 5,000 r.t.m. about 50 minutes, by a current output of 5 Amp.- stabilizing a steady-state thermical regime.
- Stop alternator and disconnect it for a short time from the battery.
- Reconnect alternator and start engine again, at a speed of 5,000 r.p.m.
- Check controlled voltage for load current going from 2 A to 30 A.

These voltage values should be enclosed in the hatched area, represented in the diagram fo fig.2.36.



2.36. REGULATING CHARACTERISTIC OF VOLTAGE REGULATOR

- If the voltage regulator is faulty, replace it. Its repairing is not advisable.
- After plotting the regulating characteristic you can, by means of a load variable resistance measure the load which can be obtained at a speed of 5,000 r.p.m. This load should be of 34 A at 14 V voltage.
- If, after replacing voltage regulator the values indicated in the Fig.2.36 cannot be obtained, perform alternator repair, checking the excitation circuit and the block of diodes.

2.2.4. BRAKE SYSTEM MAINTENANCE

In this chapter is described the maintenance of hydraulically controlled foot (servise) brake and mechanically controlled hand (parking) brake.

OP. 2.0.19.01.0. CHECKING & TOPPING UP BRAKE FLUID IN BRAKE SYSTEM

Correct brake fluid level should reach the mark "NIVEL" (Level) on the compensating reservoirs of the brake and cluth master cylinders.
For topping up use only the SUPER CS-4102201 brake fluid. If this type of fluid is not availabele, use another brake fluid, corresponding to SAE 170.3 a brake fluid, provided at the whole fluid quantity in the brake system will be changed with the new fluid.

- On topping up or changing brake fluid, check, by actuating pedals, if the holes feeding the master cylinders are free.
- If the brake fluid was completely changed, both brake & clutch hydraulic control systems should be bled, according to Op.2.0.35.02.0.

OP. 2.0.35.04.0. CHANGING [illegible] &CLUTCH HYDAULIC [illegible]EMS

St.2.0.35.04.1. CHANGING FLUID IN BRAKE CONTROL SYSTEM

- Connect to each bleed nipple of wheel brake cylinder a brake fluid - resisting hose (PVC or mipolam) and introduce their ends into transparent vessels with brake fluid.

- Unscrew (2 - 3 turns only) the bleed nipples. successively, beginning with the nearest cylinder; then depress many times the brake control pedal, until from the hose connected to the bleed nipple air bubbles getout.
- Tighten the loosened bleed nipple and repeat this operations on the next cylinder and perform so on up the most remote cylinder (rear R.H. wheel).Let this last bleed nipple open.
- Feed the master cylinder compensating reservoir with fresh brake fluid and depress many times the brake control pedal untill air bubbles stop getting out (pay attention to not let the master cylinder reservoir completely empty, refilling it with brake fluid during this operation).
- When air bubbles get no more out, tighten respective bleed nipple and repeat the bleeding the last but one cylinder loosening the bleed nipple and so The last wheel brake cylinder which should be bleeded is the nearest to the master brake control cylinder. (i.e. front L.H.wheel cylinder);

  When brake fluid changing, respectively air bleeding were correctly performed, the brake control pedal should stop being depressed before reaching the cowl - the all four wheels being braked.

  When brake pedal stroke end is not firm but rather elastic, it indicates an insufficient brake system bleeding. In that case repeat the above described operation, beginning with the most remote wheel brake cylinder, successively up to the nearest one.
- Pay attention for bleed nipple tightening and inspect them for fluid leakages.
- Finaly remove connected hoses and vessels with brake fluid.

St. 2.0.35.04.2 CHANGING FLUID IN THE HYDRAULIC CLUTCH CONTROL SYSTEM OF THE ARO CARS, EQUIPPED WITH ARO L-25 ENGINE

- Having access from the car bottom side, performe bleeding hydraulic clutch control system (see fig. 2.37), in the same manner as on changing fluid in the brake control system, according to Op. 2.0.35.04.1.

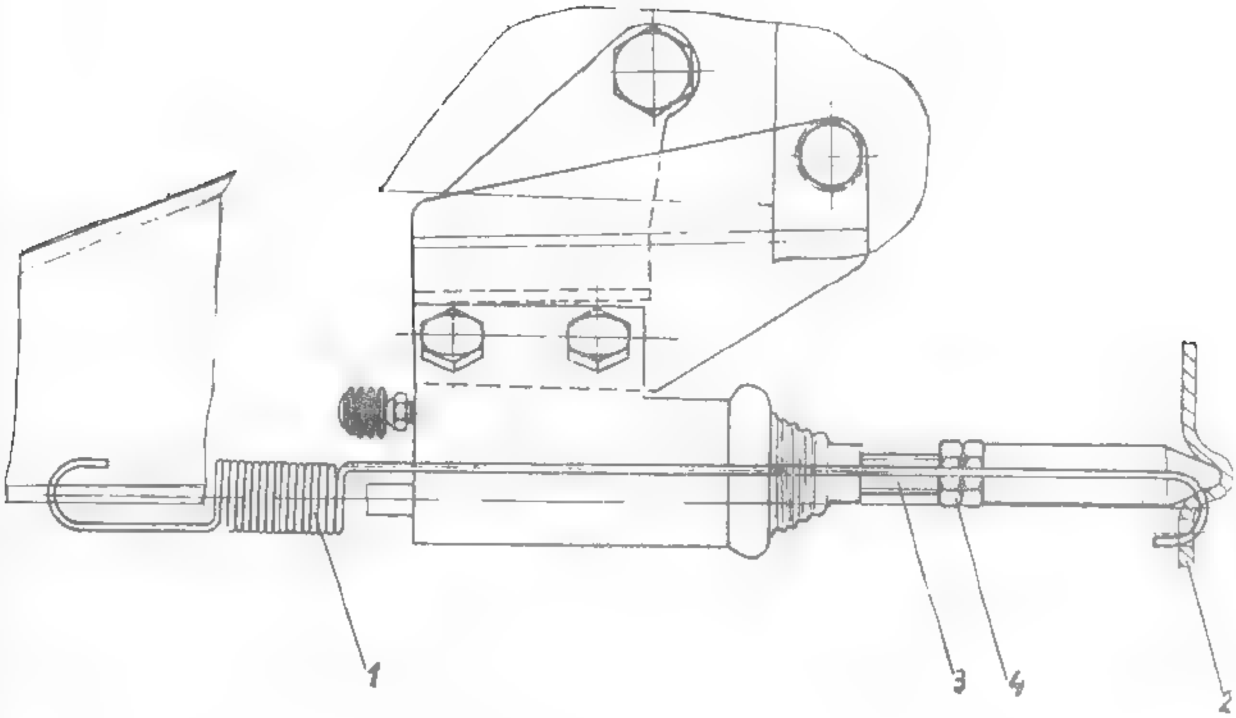


Fig.2.37. CLUTCH CONTROL MECHANISM
1. Pull-back spring; 2. Clutch release fork; 3. Slave cylinder rod, 4. Adjusting nut.

St. 2.1.35.04.3 CHANGING FLUID IN THE HYDRAULIC CLUTCH CONTROL SYSTEM OF THE ARO CARS, EQUIPPED WITH ARO D-127 ENGINE.

The access to clutch master cylinder is possible through the car inside after taking down transmission tunnel cover as described in the Op. 2.0.53.01.0

- Further performe the operation in the same manner as on changing fluid in the brake control system (Op. 2.0.35.04.1) depressing this time the clutch control pedal.

OP. 2.0.35.02.0 BLEEDING [illegible] HYDRAULIC CONTROL SYSTEM

- This operation is performed in the same manner as Op. 2.0.35.04.0, except the draining out the fluid existing in the system.

OP. 5.0.99.06.0 CHECKING SERVICE (MAIN) BRAKE SYSTEM

Checking is performed on special test stand, measuring the brake power o each wheel, or along a test trip fulfilling the below indicated conditions. The car brake system has a play self-adjusting mechanism for self-compemsating of brake shoes wear, so that normally the brake power of R.H. wheels is equal to tthat of L.H.wheels. In case that special cheker indicate the brake powers having a difference between them more then 15%, it should be performed a brake system remedying, by checking of brake cylinders, brake shoe and brake drums.

- If the special brake power checker is not available, performe a braking test along a road having at least 4 meters width and a good adherence (asphalt, concrete) at a speed of 40 km/h and in dry weather.
- At this speed, on depressing progressevely the brake pedal, the car should stop on a distance of 12 m. without deviating from the straight line.
- If the brake power of R.H.wheel is different from that of L.H.wheel and the car will deviate on braking, the remedying of the brake system is necessary.
- For this, check which wheel had less brake power, indicated by the brake power checker, or, if the checker was not available, which wheel remained outwards the curved car trace. The necessary intervention should be performed on this wheel.

OP. 2.0.35.01.0 INSPECTING SERVICE BRAKE CONDITION

- Lift the car upon the inspection ramp.
- Inspect the car underside for brake fluid leakages from wheel brake cylinders (radial fluid traces on the inner side of wheel rims, for fluid leakages from pipe assembling nuts, for copper lines blows which can narrow down the brake pipes as well as for brake hose blisters.
- Inspect under the engine bonnet connections between the compensating reservoirs and the master cylinders, as well as between cylinders and the rest of brake system.

- Depressed brake pedal should stop firmly before reaching the cowl.
- Replace faulty parts with new ones. If depressed brake pedal does not stop firmly, bleed again the brake system, as described in the Op. 2.0.35.02.0.

OP. 2.0.19.02.0 CHECKING AND EVENTUALLY ADJUSTING BRAKE CLUTCH PEDAL POSITION AND STROKE

- The operation is carried out inside the car (see fig. 2.38). For this:
- Set adjusting device V.101 on body floor under pedal.
- Now adjust pedal position adjusting screw (1) till the lower point of pedal touches the top margin of V.101 device and adjusting screw contacts cowl. Now, tighten back nut of the screw (1).
- To adjust pedal stroke, slacken lock nut (4) and screw or unscrew piston pushing rod (5) so that a small play remains between piston and piston pushing rod (5), allowing a 10-15 mm free travel of pedal.
- In this position of piston pushing rod tighten lock nut (4).

OP. 2.0.01.22.1 ADJUSTING THROWOUT BEARING CEEARANCE OF ARO L-25 ENGINE (see fig. 2.37)

This operation is accessible from car underside.

- Set free the pull-back coil spring (1) and push clutch release fork (2) till the throwout bearing contacts adjusting screws of clutch release levers (see also fig. 4.93).
- In this position tighten adjusting rounded nut, till it contacts release fork (2); then slacken it back two turns in order to secure necessary clearance for throwout bearing.
- In this position tighten lock nut (4), retaining piston pushing rod, by means of a screw-driver, introduced in rod slotted hole.

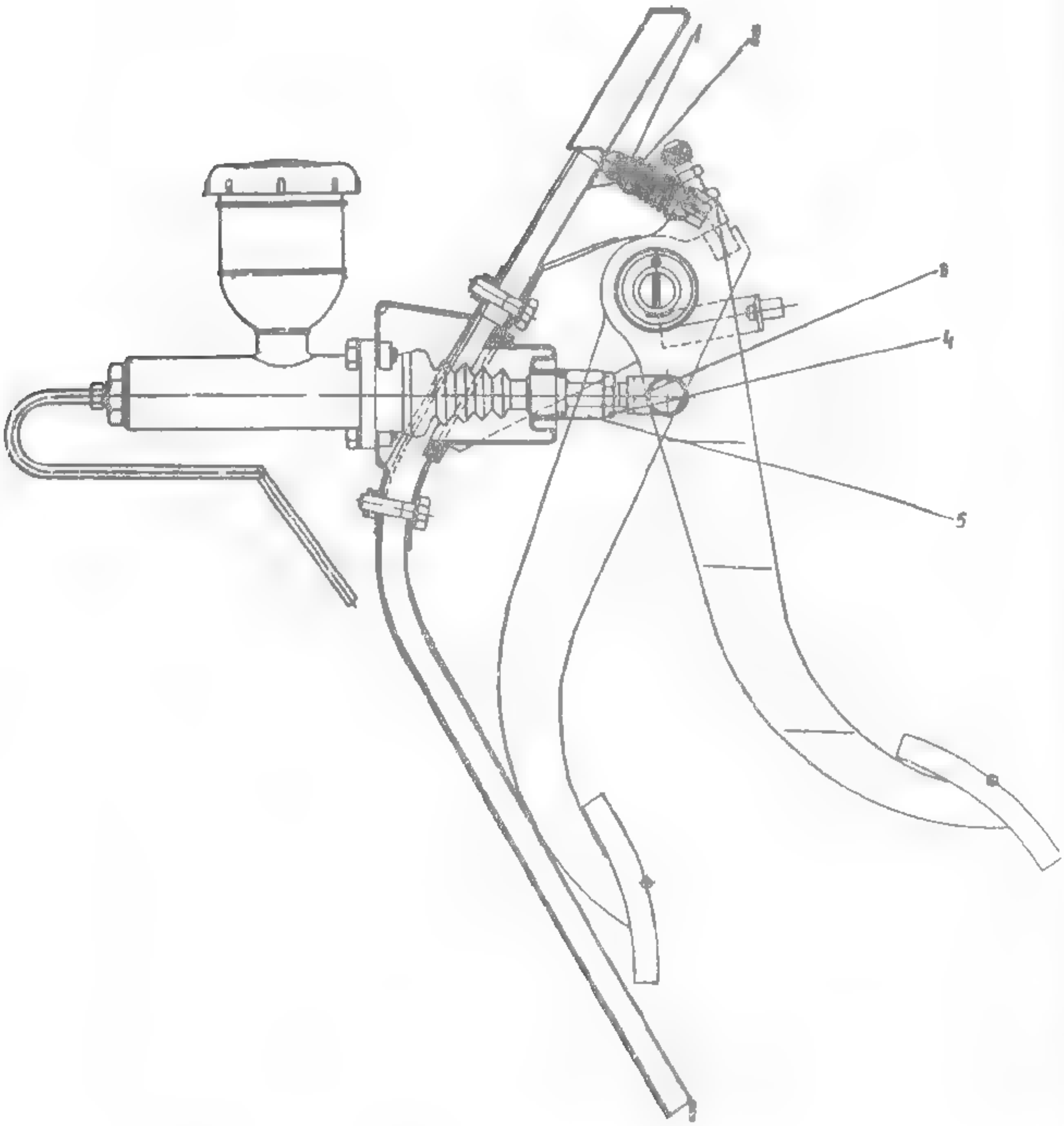


Fig. 2.38. BRAKE & CLUTCH HYDRAULIC CONTROL SYSTEM
1. Clutch brake position adjusting screw; 2. Stop screw (1) locking nut; 3. Forked rod; 4. Lock nut; 5. Piston pushing rod.

OP. 2.1.01.18.2-D ADJUSTING CLUTCH THROWOUT BEARING CLEARANCE OF ARO D-127 ENGINE

This operation can be carried out having access inside the car, after removing transmission tunnel cover, as described in Op. 2.0.53.01.0.

- After removing the cover, perform clearance adjustment as described in preceding operation (2.0.01.22.1).

OP. 2.0.35.06.0 CHECKING BRAKE SHOES WEAR.

This operation is performed according to maintenace schedule but also when a braking trouble is found on its inspection, according to paragraph 5.0.99.06.0.

- Take respective wheel down, as described in Op. 2.0.31.01.1.
- Before checking brake shoes wear check play self-adjustment mechanism condition.

St. 2.1.35.06.1 CHECKING PLAY SELF-ADJUSTMENT MECHANISM

- Depress brake pedal till it stops and then release it slowly.
- Introduce feeler gauges through the brake drum opening (see fig.2.39) and check the clearance between brake drum surface and brake shoe linings. The found value should be comprised between 0.2 and 0.3 mm.
- Rotating the drum check clearance along each shoe.
- Repeat checking clearance after a few minutes. If the found clearance value will be greater the play self-adjusting system, inside the brake cylinder is faulty and should be replaced with a new, original part.

St. 2.1.35.06.2 TAKING BRAKE DRUM DOWN FOR CHECKING SHOE LININGS WEAR

- Taking brake drum down needs preliminary taking down of respective wheel, as described in Op. 5.0.99.06.0.

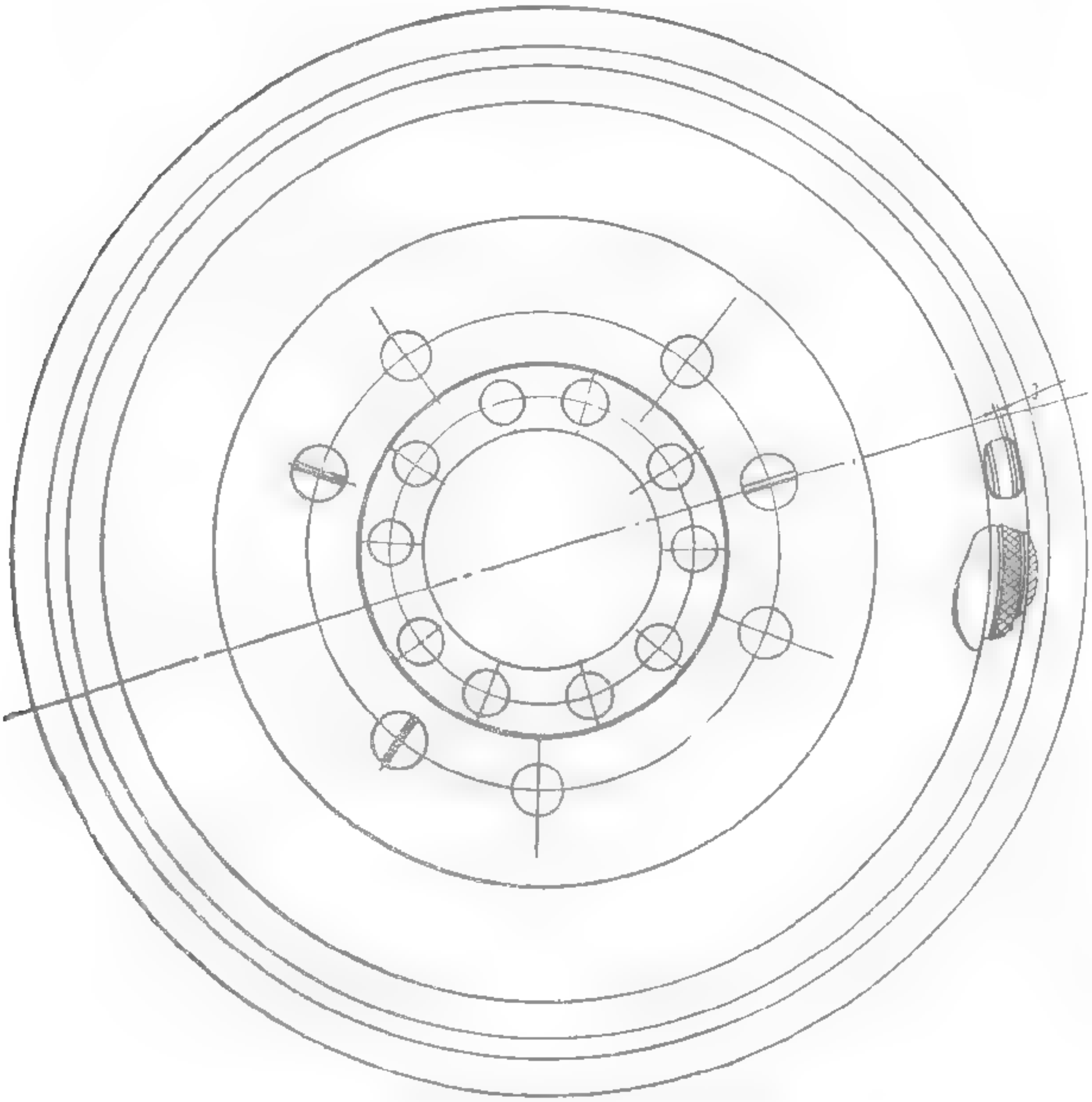


Fig. 2.39. BRAKE DRUM OPENING FOR ADJUSTING THE BRAKE SHOES THE CLEARANCE.

- After taking down the wheel, remove brake drum from the wheel hub, after having unscrewed the fastening bolts, remove the drum by slight lateral blows, using a rubber or plastic hammer.
- Inspect shoe lining riveting: the rivet heads should be under the shoe lining surface. If not, replace respective brake shoe.

On refitting brake drum perform operation in reverse order.

St. 2.1.35.06.3 CHANGING BRAKE SHOES OF THE FRONT WHEELS

This operations needs preliminary taking down of the wheel and the brake drum, as above described (St. 5.0.99.06.0 and 2.1.35.06.2).

- Push brake shoe (2) (see fig. 2.40) outside, against the spring (4) action, untill the shoe rib gets out from cylinder back slot, move the shee laterally and release it slowly near the cylinder back slot.
- Perform in the same manner with the second shoe, now both shoes are free and can be removed from the brake anchor plate (1).
- On refitting brake shoes fasten firstly the two springs (4) into respective holes of each shoe, introduce on shoe end in the respective cylinder back slot. Them, using still a lever, push the second shoe outside and introduce its end into the slot of the second cylinder.
- Blow slightly bot shoes, by means of a rubber hammer, in order to set them correctly, under strong spring action, in the cylinder slots.
  ATTENTION! As long as the both shoes are taken down or fitted on their correct place, but without brake drums, do not depress the brake pedal, because the brake pistons under fluid pressure will be damaged by shifting and blocking!

- On refitting brake drum bring firstly both shoes in their initial position (building a cylindrical surface), blowing them slightly with a rubber hammer, parallelly to cylinder axis.

St. 2.1.35.06.4 CHANGING BRAKE SHOES OF THE REAR WHEELS

Taking down brake shoes of rear wheels needs preliminary operations i.e. taking rear wheel down (Op. 5.0.99.06.0), taking brake drum down (Op. 2.1.35.06.2) and disconnecting parking brake system from rear wheel, as decribed below (St. 2.0.35.06.2).

St. 2.0.35.06.5 DISCONNECTING PARKING BRAKE FROM REAR WHEELS BRAKING SYSTEM

- Loosen parking brake Bowden cable pushing forwards brake control handle and then slacking nut (4) and lock nut (5) - (see fig. 2.41), unscrewing both untill the cable is loosened, i.e. up to the end of adjusting rod (3) (access from car underside).

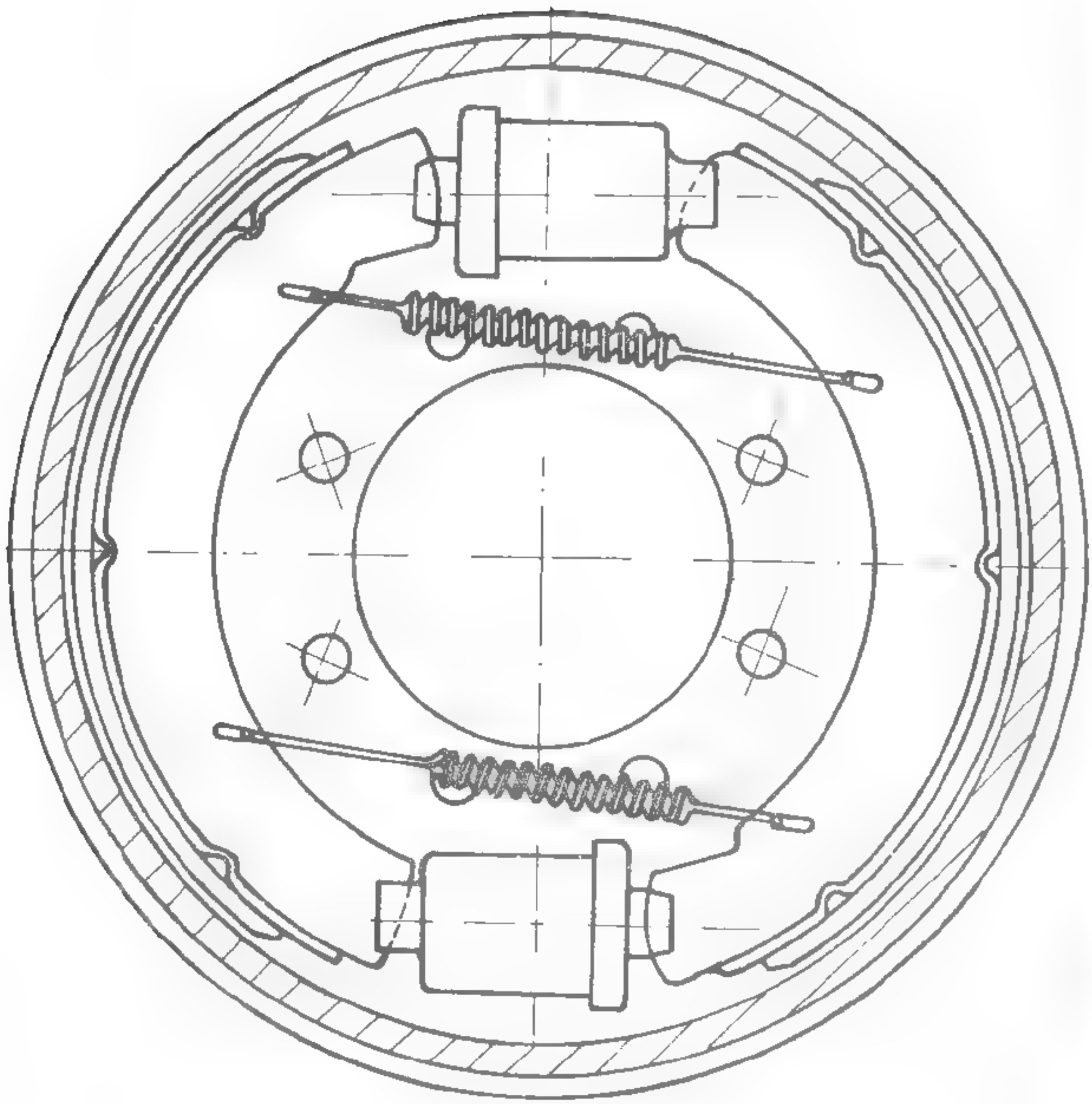


Fig.2.40. FRONT WHEEL BRAKE ANCHOR PLATE
1. Front brake anchor plate; 2. Brake shoe; 3. Front wheel brake cylinder; 4. Retracting spring.

- If after repeated adjustments both nuts have reached the end of adjusting rod (3), remove completely both nuts and brake pulley fork, making free the Bowden cable and respectively the parking brake mechanism.

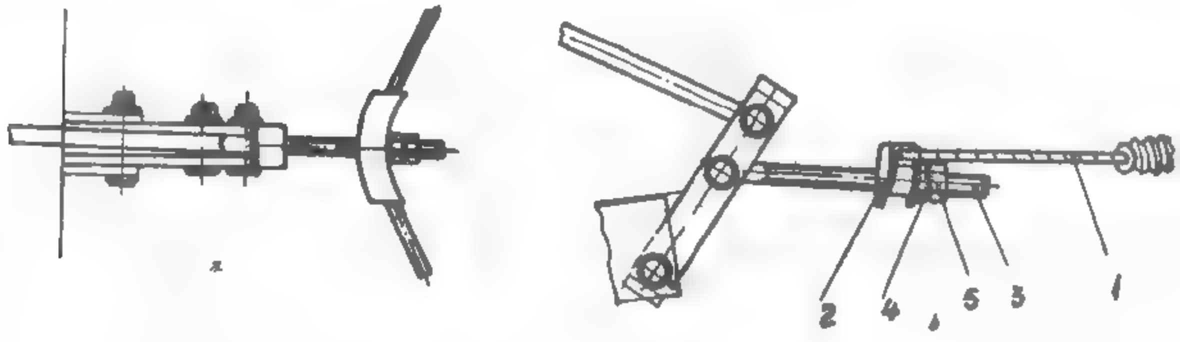


Fig.2.41. BOWDEN CABLE TENSION ADJUSTING SYSTEM FOR HAND BRAKE CONTROL.
1. Brake cable; 2. Distributing piece; 3. Threaded rod; 4. Cable tension adjusting nut; 5. Lock nut.

- On refitting perform operations in reverse order.

ATTENTION! After changing worn out brake shoes with new ones, having different thickness, a readjusting of parking brake get necessary, naturally after refitting brake shoes and drum.

St. 2.1.35.06.6 TAKING REAR WHEEL BRAKE SHOES DOWN

- After loosening Bowden cable of parking brake, the levers controling the brake shoes get free in their hinges and can be positioned in a suitable manner.
- Using a lever (see fig.2.42) remove the end of one shoe from brake cylinder slot and then from shoe support.
- The free shoe loosen the both retracting springs, making so possible removing of the second brake shoe.
- On refitting brake shoes perform operations in reverse order.

Pay attention for correct setting of parking brake control levers and for correct setting of brake cylinder boots, i.e. the brake shoe rib should not press and damage the boots.

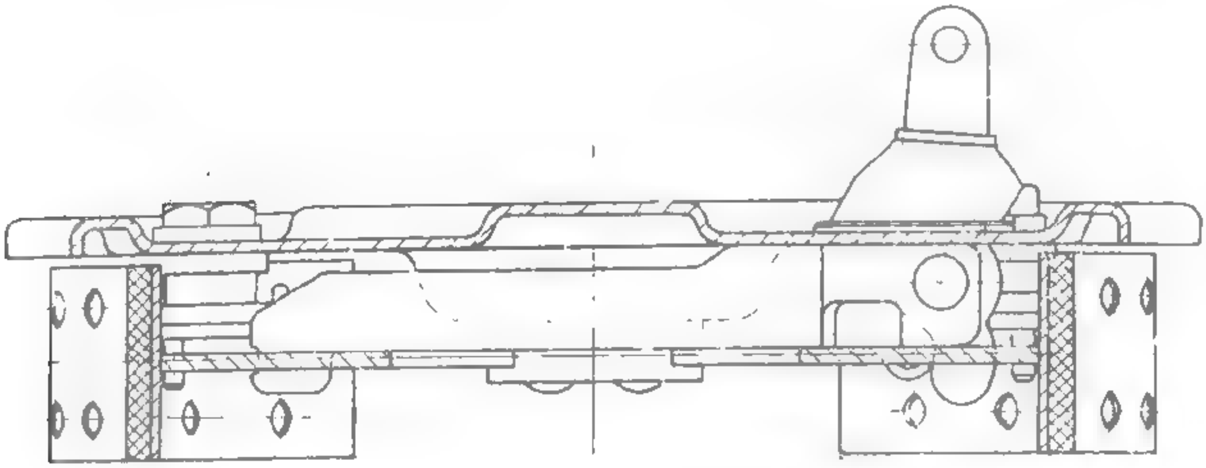


Fig.2.42. REAR WHEEL BRAKE ANCHOR PLATE.

- Perform refitting similarly with refitting front wheel brake shoes (Op. 2.1.35.06.3).

St. 2.0.35.06.7 ADJUSTING PARKING BRAKE

- Put a jack behind one of the rear wheels and lift the car, till the wheel gets free.
- Push parking brake control handle forwards up to refuse.
- In this handle position tighten adjusting nut untill the Bowden cable is tightened up and the free rear wheel is braked.
- Then slacken gradually the nut untill the wheel can be rotated.
- Lock the adjusting nut by tightening counter nut (adjusting rod should get out of nut at least (5 mm).

  After performing this adjusting the parking brake should hold at most on the fifth tooth of the notched locking quadrant.

OP. 2.1.35.05.0 CHANGING PISTON CUPS OF BRAKE & CLUTCH MASTER CYLINDER (see fig.2.43)

- Disconnect master cylinder from the brake control pedal by loosening the counter nut and then by unscrewing completely the piston pushing rod (3) (see fig.2.43).

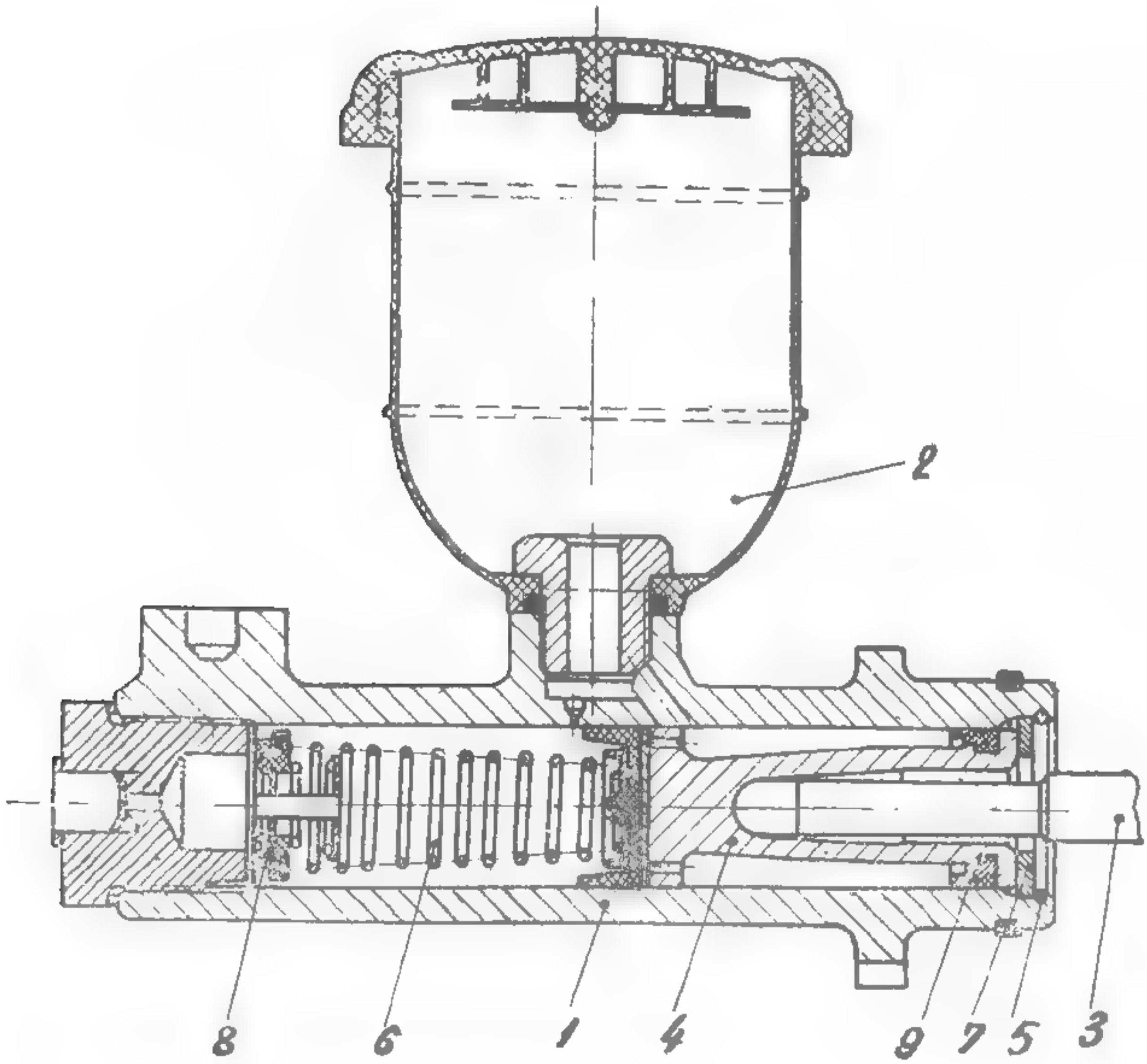


Fig.2.43. BRAKE MASTER CYLINDER
1. Master cylinder; 2. Compensating brake fluid reservoir; 3. Piston pushing rod; 4. Master piston; 5. Clip ring; 6. Master cylinder spring; 7. Thrust collar; 8. Valve for brake system pression; 9. Master piston cup.

- Disconnect electrical leads (from the brake master cylinder) and all connecting pipes from both brake and clutch master cylinders.
- Protect with plastic plugs or polyethylene foil, in order to avoid penetrating of impurities into hydraulic circuit.
- Unscrew the cylinder fastening bolts: access may be got from below the engine bonnet.

- Carefully remove both cylinders, paying attention to not damage rubber bellows seals on passing them through the cowl opening.
- Now all operations should be performed on a perfect clean bench, covered with a thick polyvinyl foil or brake fluid resisting rubber foil.
- Remove piston pushing rod together with the rubber bellows seal.
- Push piston inside the cylinder by means of a rod and remove the snap ring (5). The spring (6) pushes thrust collar (7) and piston (4) out of cylinder. Going on, remove the spring (6) and the valve (8).
- Replace rubber cups (inclusive the retaining valve) only with new original parts.

  Fit piston rubber sleeve (9) using only S.109 mandrel.
- Perform refitting brake & clutch master cylinders and their mounting on the car in reverse order.
- It is recommended, before mounting master cylinders on the car to proced to a tightness test by applying a pressure of 90 kg/cm^2 (bars) for 3 minutes; no brake fluid leakages should be observed.
- After remounting cylinders on the car, adjust the pedal stroke, according to Op. 2.0.19.02.0 and bleed hydraulic control systems (brake and clutch), without changing the fluid.

St. 2.1.35.05.2 CHANGING PISTON CUPS OF FRONT WHEEL BRAKE CYLINDERS

- Put a jack under respective wheel lift the car and take down:
  - The wheel, according to Op. 5.0.99.06.0
  - The brake drum, according to Op. 2.1.35.06.2
  - Brake shoes, according to Op. 2.1.35.0.6.3
- Getting access from the car underside disconnect brake cylinders from hydraulic brake control system, unscrewing the pipe fastening nuts.
- Protect the free pipe ends with plastic plugs or polyethylene foil, in order to avoid penetrating of impurities into hydraulic circuit.

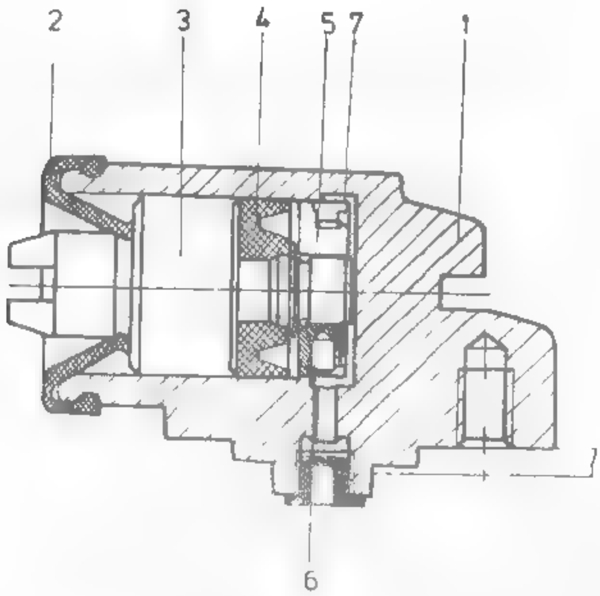


Fig. 2. 44. FRONT WHEEL BRAKE CYLINDER.
1. Brake cylinder; 2. Brake cylinder boot; 3. Brake piston;4. Front brake piston cup. 5. Nut of brake shoes selfadjusting mechanism; 6. Spring positioning pin; 7. Ring spring.

- Unscrew nuts fastening brake cylinders on the brake anchor plate, getting access from underside the car.
- Going on, perform the successive operation on a bench (see fig. 2. 44).
- Remove firstly brake cylinder boot (2) and then the piston with its rubber cup (5) and (4). Check the spring for oxidation traces; if oxidation traces or rust spots will be found, renew the spring.
- Fasten then cylinder in a bench vice, paying attention to not deforme it ! (for great series use special device).
- Using the special S. 301 wrench, unscrew piston and remove it together with rubber cup, if the last one is damaged.
- Inspect cylinder surface for visible scratches and if there are fine scratches, it is allowed to polish cylinder surface using only very fine emery paper (granulation 800 and more). Polish surface untill its roughness will disappear.
- If scratches will not disappear after a slight polishing, replace cylinder and the piston.

ATTENTION! It is forbidden to remove the nut with its spring, which constitute the self-adjusting mechanism of brake cylinder. Their removing will cause grave cylinder surface damaging and put cylinder definitly out of operation.

- Remove rubber cup from the piston and wash it in clean brake fluid.
- Inspect the new rubber cup, which is to be fitted, using a magnifying lens. On the sealing edge there should not be any visible fault. Use only original rubber cups!
- Fit new rubber cup on the piston by means of the special S. 302 drift. To make fitting easier lubricate the cup but only with brake fluid.
- Screw the piston in the nut which is left in the cylinder.
- After refitting completely the brake cylinder perform a pressure test by means of D 302 manual pressure device, applying a pressure of 90 kg/cm^2 (bars) for 3 minutes. In this time no fluid leakage should appear.
- Now perform remounting brake cylinder with the new piston cup on the car, in reverse order as on dismantling it. Pay special attention by tightening all nuts of fluid pipes.
- Bleed the brake system, as described in Op. 2. 0. 35. 04. 0 - except the fluid changing.

St. 2. 1. 35. 05. 3 CHANGING PISTON CUPS OF REAR WHEEL BRAKE CYLINDERS

- Loosen the parking brake Bowden cable by unscrewing counter nut and the threaded sleeve mounted on adjusting rod (see Op. 2. 1. 35. 05. 2).
- Lift the car on a jack and remove the wheel.
- Perform all operations similarly as described above, concerning the front wheel brakes.
- Finaly bleed the brake system and adjust the parking brake, according to Op. 2. 1. 35. 06. 7.

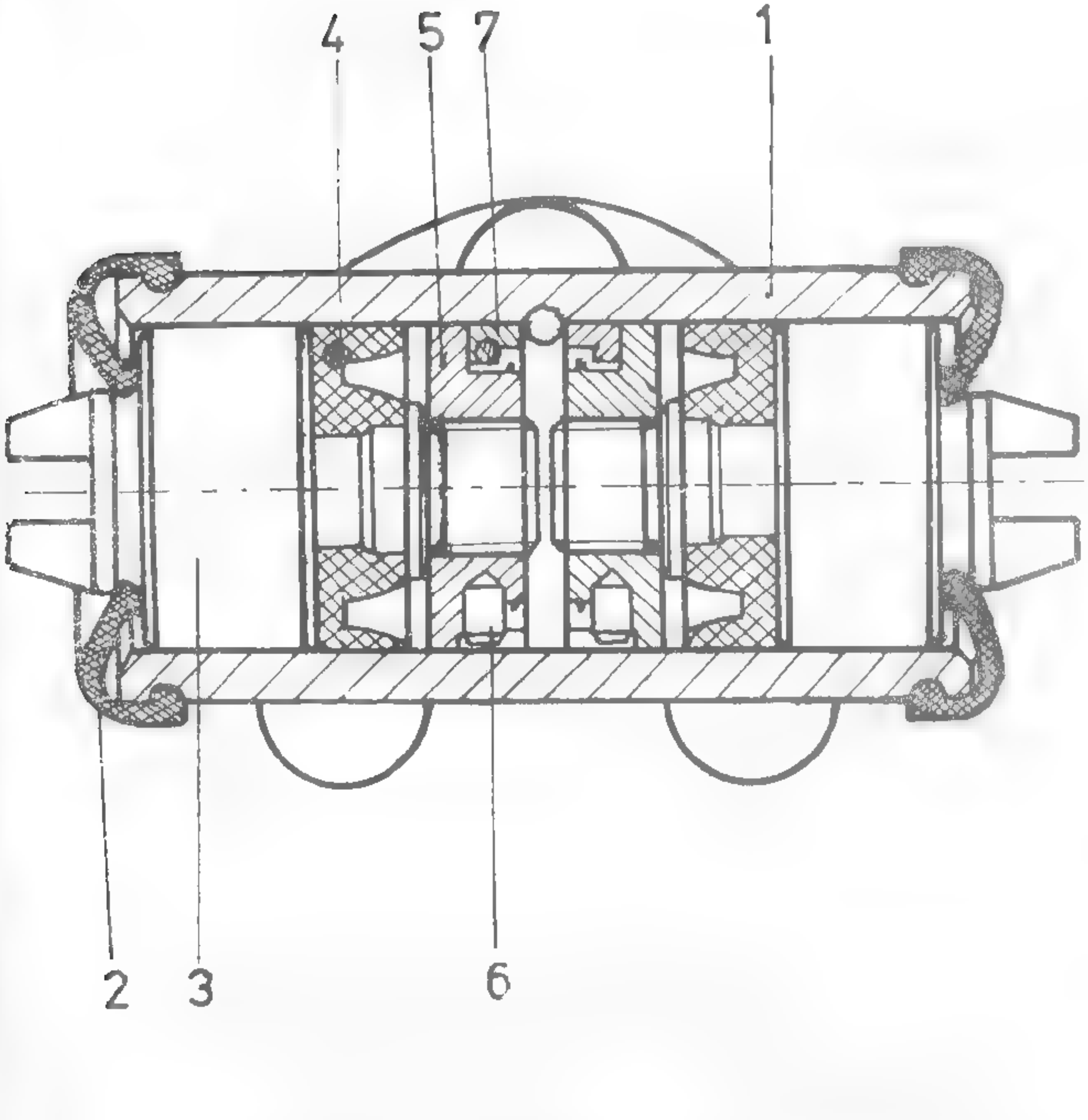


Fig. 2.45. REAR WHEEL BRAKE CYLINDER
1. Brake cylinder; 2. Brake cylinder boot; 3. Brake piston; 4. Brake piston cup; 5. Nut of brake shoes selfadjusting mechanism; 6. Spring positioning pin; 7. Ring spring.

St. 2.0.35.05.4 CHANGING PISTON CUP OF CLUTCH CONTROL SLAVE CYLINDER, MOUNTED ON ARO-L-25 ENGINE.

- Getting access from underside, undo connection between slave cylinder and clutch release fork, as well as connection with clutch control hydraulic system.
- Take down slave cylinder from clutch housing.
- Perform the following operations, on a workshop bench,
- Remove slave cylinder boot (8) and pushing rod (2) - (see fig. 2.46).
- Remove snap ring by means of S 102 nose pliers and after it the piston with rubber cup (4).
- If necessary, replace rubber cup with a new, original one.
- Fit new rubber cup on piston by means of S 110 mandrel. Before fitting the cup lubricate it, but only with clean brake fluid.
- Refit clutch slave cylinder and mount it on the car, performing all operations in reverse order.
- Adjust clutch throwout bearing clearance, as described in Op. 2.0.01.22.1 and bleed clutch hydraulic control system, according to Op. 2.0.35.02.0.

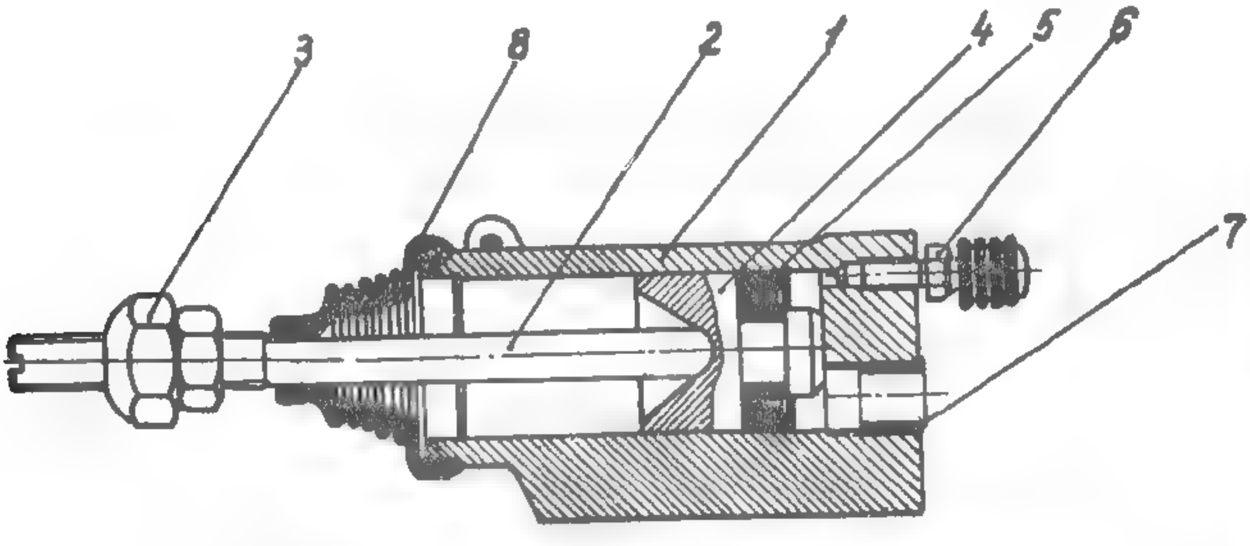


Fig. 2.46. CLUTCH CONTROL CYLINDER.
1. Slave cylinder; 2. Piston pushing rod; 3. Rounded adjusting nut; 4. Slave piston; 5. Slave piston cup; 6. Bleed nipple; 7. Feeding connection; 8. Slave cylinder boot.

St. 2.0.35.05.5D CHANGING PISTON CUP OF CLUTCH CONTROL SLAVE CYLINDER, MOUNTED ON ARO D-127 ENGINE

- To get access to clutch control slave cylinder take down preliminary transmission tunnel cover, as described in Op. 2.0.53.01.0.
- The other operations are the same as for ARO L-25 engine, (see Op. 2.0.35.05.4).

OP. 5.0.99.07.0 CHECKING HAND PARKING BRAKE

- Lift the car upon an arranged ramp or a road having a gradient of 30% (about 16^{o}), stop it by actuating main, hydraulic brake and, by applying a force of about 40 daN (kg), pull the parking brake handle.

  On slacking the main hydraulic brake, the car should remain motionless on the ramp (braked). If not, perform the adjusting of parking brake, as described in Op. 2.0.35.06.7.

OP.- 2.0.35.03.0 INSPECTING PARKING BRAKE CONDITION

- Pull parking brake handle, which should reach at most the fifth tooth of notched locking quadrant. If brake handle climbs beyond the fifth tooth, perform brake adjusting as in Op. 2.0.37.06.7.
- Getting access from underside of car, check if counter nut is well tightened, if there are no oxidation areas on the cable; if yes, the Bowden cable should be replaced (see: Overhauling the parking brake).
- Check cable fastening on car chassis and if cable does not touch moving or vibrating parts.
- Check cable protecting envelope condition.

2.2.5. MAINTENANCE OF STEERING SYSTEM

A correct operation of steering system is determined by steering gearbox, hinges correct conditions, by tyre balance and pressure, by steering wheels angles.

OP. 5. 0. 99. 09. 0 CHECKING STEERING SYSTEM CONDITION

- Driving on road, check if on curvatures the necessary force to turn steering wheel is equal in both senses, without any friction or jaming tendency. There should not be steering wheel trepidations.
- Observe if driving on shourt curvatures the tyres do not touch steering system components.
- On driving out of a road curve the steering should return in its forward running position. At the end a slight correction of steering wheel position is allowed.
- Check the car running straight forwrds:

  On a horizontal, dry road, having no lateral wind, a car, running at a moderate speed of 30 - 40 km/h, straight worwards, when the steering wheel is left free should not deviate laterally more then one meter on a distance of 50 meters.

  If above mentionned troubles will occur, perform necessary interventions, described in the chapter "Repairs".

OP. 2. 0. 34. 05. 0 ADJUSTING STEERING WHEEL ANGULAR PLAY

Driving a car straight forward, the angular play of steering wheel should not exceed 15^{o} (about 50 mm on steering wheel periphery).

As far as a great angular play makes difficult the car controlability it is necessary to adjust the clearance between steering roller and steering hourglass worm of steering gearbox, as follows:

- Bring front wheels in "straight ahead" position, by turning steering wheel.
- Getting access from underside of car, unscrew locking nut (1) - (see fig. 47) and remove it together with external tooth lock washer (2).
- Turn clockwise adjusting screw (3) untill angular play of steering wheel reaches acceptable limits, but without making difficult the steering wheel rotation.

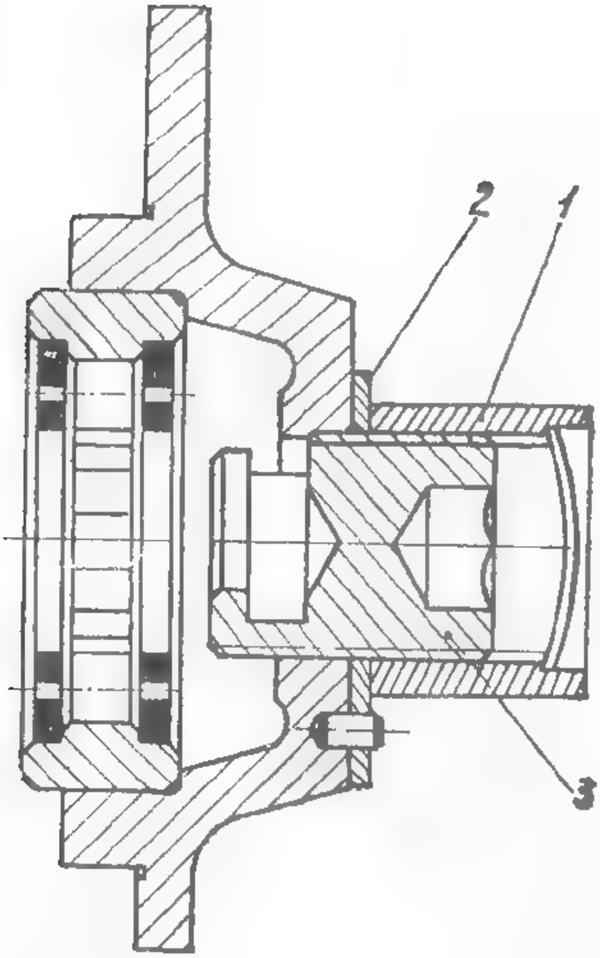


Fig. 2. 47. STEERING WHEEL ANGULAR PLAY ADJUSTING SYSTEM.
1. Nut locking angular play adjusting screw (3); 2. External tooth lock washer; 3. Adjusting screw.

- In order to judge the results of adjusting, lift the car, by means of a jack, so that both front wheels lose touch with the ground.
- In case that the adjusting screw (3) was tightened up to refuse, but the steering wheel play did not decrease, it means that this play results from steering drag link knukles or from steering spider and the trouble remedyed according to indications of chapter "Repairs".
- After performing play adjusting refit the lock washer (2) and locking nut (1).

OP. 2.0.31.02.0 CHECKING TYRE PRESSURE

The tyre pressure should be checked when in an .ambient temperature (in summer, about 25°C and in winter, about 0°C).

At indicated temperatures the tyre pressure should have the following values:

- Front wheels:	for all ARO 24 car models	2 bars (kg/cm^2)
	for ARO 320 models	3 bars
- Rear wheels:	for ARO 240; 241; 243; 244 models	3,25 bars
	for ARO 242 model	3,5 bars
	for ARO 320 model	5 bars

For the aro 24 cars equiped with JR 78-15 tyres the pressures will have the following values: front wheels: 2 bars; rear wheels = 2,5 bars

OP. 5.0.99.10.0 CHECKING AND ADJUSTING TO-IN

This operation can be carried out using a mechanical checker as well as on an optical bench.

- On using a mechanical checker, lift the car on an inspection ramp, having front wheels in "straight ahead" position.
- Measure the distance between wheel rims, as shown in the fig. 2.48, performing both measurements in horizontal plane.

  It the difference between the two distances $a_2 - a_1$ has not the indicated value (1... 4 mm), performe the "to- in" adjusting, as follows:

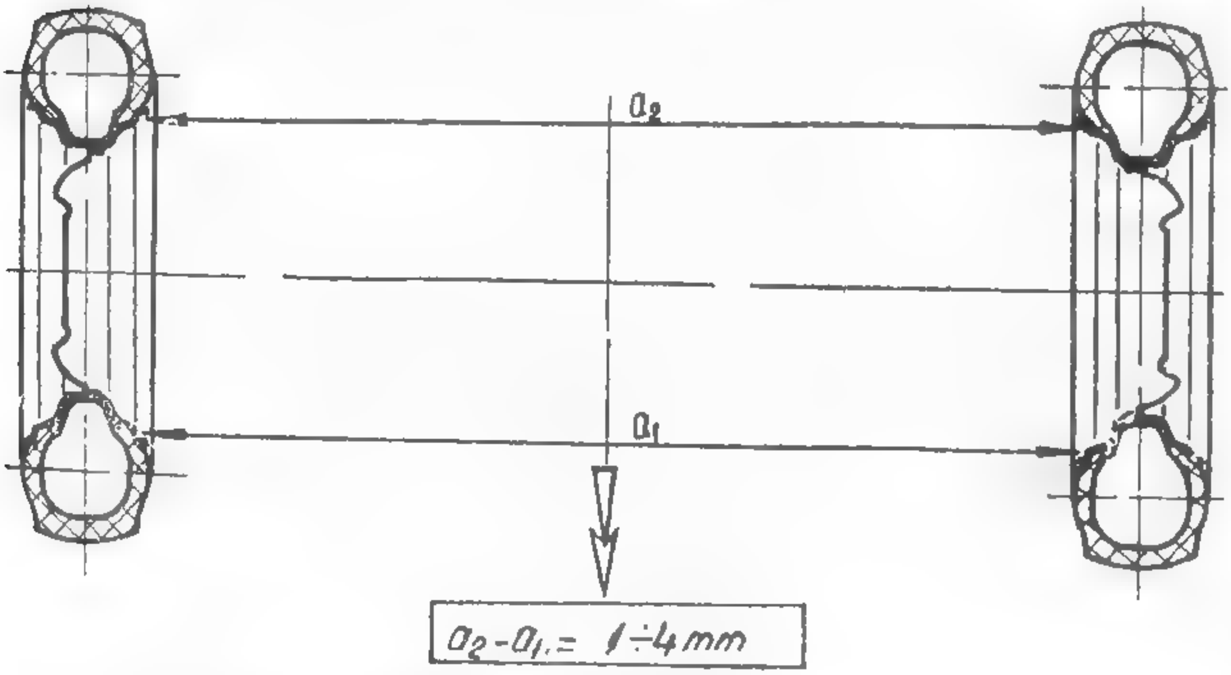


Fig. 2.48. MEASURING FRONT WHEEL TOE-IN.

- Remove split pins of the nuts tightening the draglink clamps, and slacken the nuts.
- Turn in the same sense the R.H. and L.H. draglink untill the correct to-in value is obtained.
- Tighten the nuts with a torque of 0.9 ... 1.5 daN.m (kg.m) and secure the nuts with new 1.6 x 25 slit pins.

  ATTENTION: A wrong to-in adjusting leads to rapid wear of tyres (fish scales shaped) and causes steering instability.

OP. 2.0.31.03.0 CHANGING WHEELS BETWEEN THEM

After a car running of about 6000 km, in order to obtain an unifrom wear of tyres, i.e. their maximal endurance, perform the changing of wheels between them, as shown in the fig. 2.49.

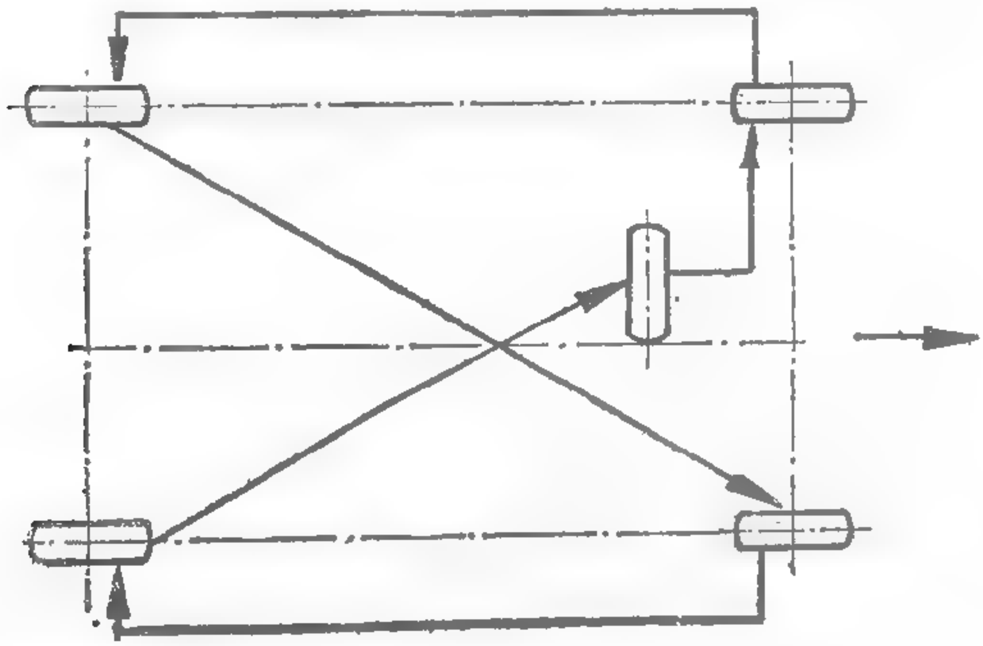


Fig. 2.49. DIAGRAMA OF CHANGING WHEELS BETWEEN THEM.

If a tyre blow off occurs, change respective wheel with the spare wheel Then, at first stopping at a SERVICE workshop refit the faulty wheel and perform again its dynamic balancing (see Op. 2.0.99.13.0).

- Take down the spare wheel and fit repaired wheel on its place, in order to respect the above indicated wheels changing (fig. 2. 49).

OP. 2. 0. 09. 13. 0 DYNAMICAL BALANCING OF WHEELS

The wheel balancing is carried out on special checking and dynamicaly balancing machines.

The wheels which have an unbalance less than 60 grams in the area of rim edge (ø 400 mm) can be considered as acceptable for further running.

If the found unbalance is more than 60 g performe dynamical balancing of the wheel using original counterweights or weights which fit on the wheel rim, fastened with clamps in such a manner that an accidental detachment will be impossible.

If the found unbalance exceeds 140 g. in both planes, a balancing by means of counterweights is not recommended and a remedying should be performed, as described in the chapter "Repairs".

Unbalanced wheels cause steering wheel vibration and car instability.

OP. 5.0.99.10.0 CHECKING AND ADJUSTING STEERING WHEELS ANGLES

On ARO jeep cars the steering wheel angles can be adjustet, i.e. camber, caster and maximal steering angle, while the king- pin camber doubled with wheel camber can be only checked, with a view of an eventual overhauling of the car which has suffered an accident.

For checking the angles is necessary a special, optical tester, which is an universal tester, for all small and middle vehicles. As a rule, the car is brought on the mobile platforms of the tester. The car should have correct tyre pressure (as indicated in Op. 2. 0. 31. 02. 0), steering wheel angular play up to 15^{o} and steering wheel to-in of 1...4 mm). If necessary, the angular play should be firstly adjusted, as described in Op. 2. 0. 34. 05. 0.

- Performe measurements according to tester instructions.

St. 5.0.99.10.1 CHECKING AND ADJUSTING CAMBER ANGLE

The camber angle value is $1^{o} \pm 30'$, provided that between the R.H. and the L.H wheel the angle difference should not be more than 45', (see fig. 2.50).

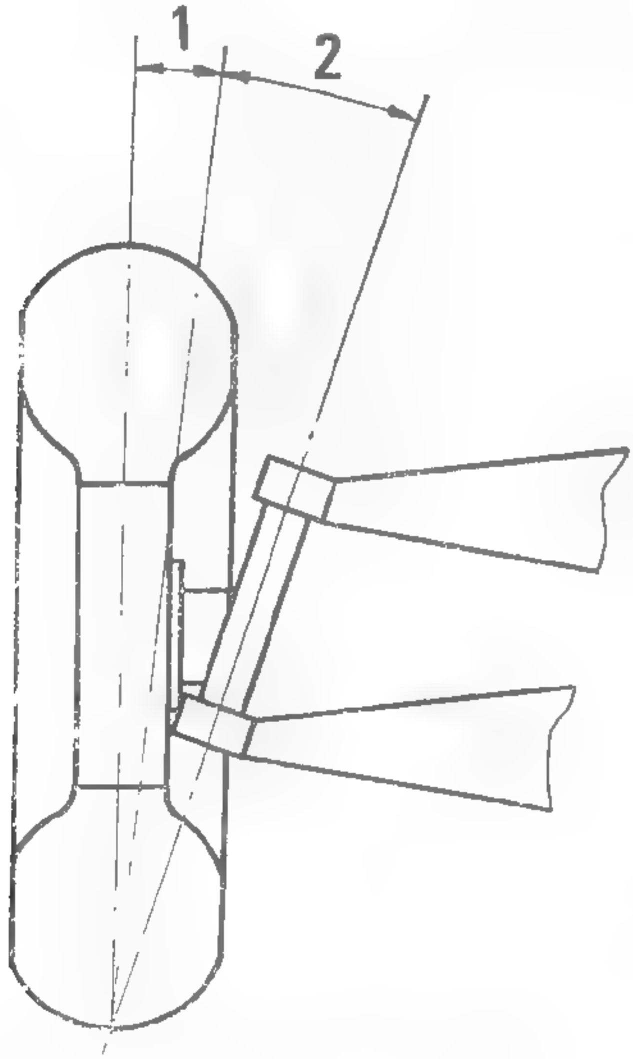


Fig. 2.50. FRONT WHEEL KING-PIN CAMBER ANGLE
1) Wheel camber angle; 2) King-pin camber angle.

If this condition is not fulfilled, perform respective adjusting. (see fig. 2.51).

For this:

- **Remove counter nuts (1) from upper control arm support (3).**
- **Slacken nuts fastening the support (3) and remove or introduce adjusting plates, equaly on both bolts, knowing that for each adjusting plate of 1 mm thickness the camber angle changes with $0,25^{o}$, i.e. 15'.**

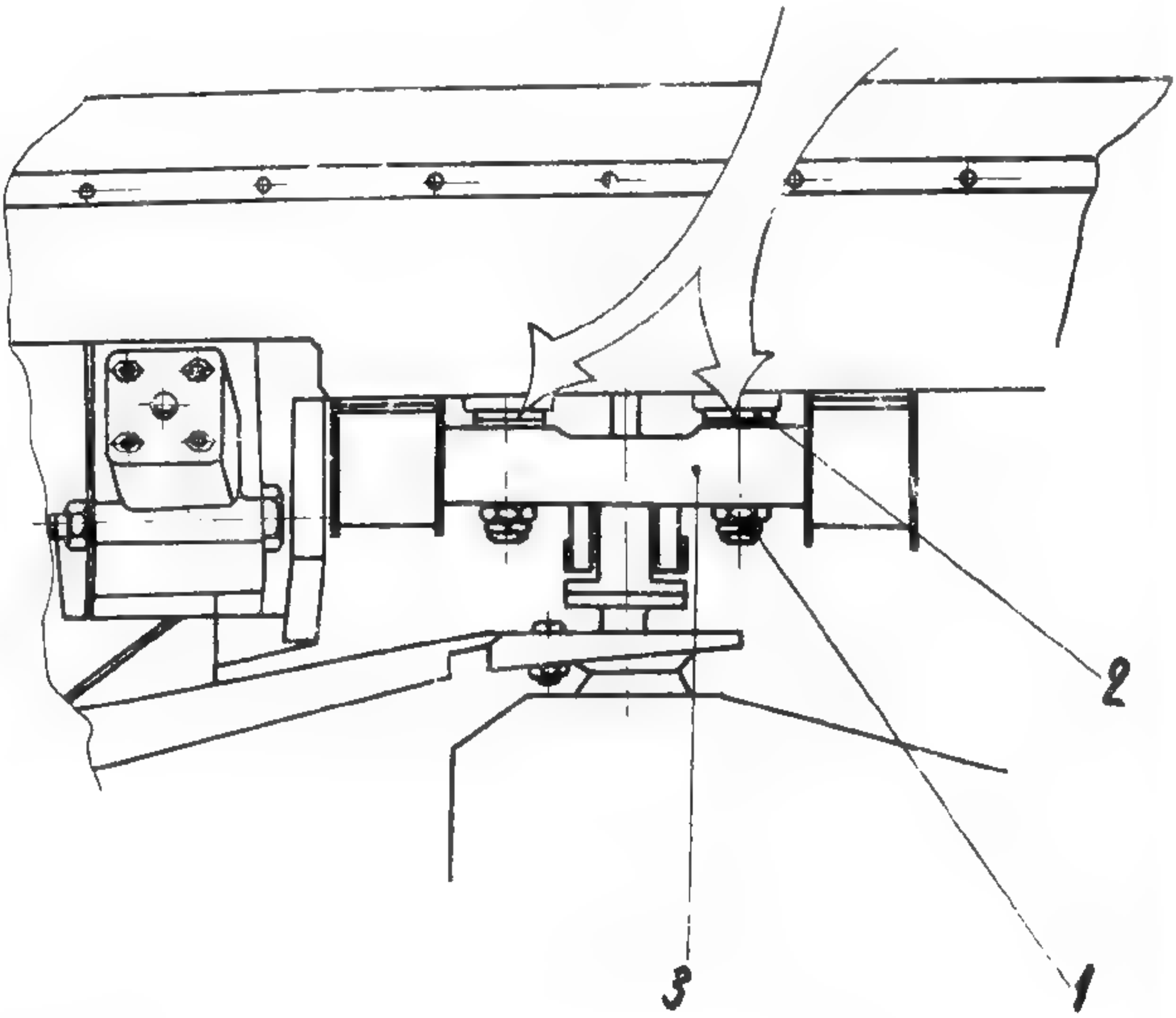


Fig. 2. 51. ADJUSTING CAMBER &CASTER ANGLE
1. Fastening nut; 2. Adjusting washer set; 3. Upper control arm bracket.

By adding adjusting plates the camber angle decreases; by taking out, it increases.

- Tighten then the nuts and counter nuts with a torque of 7 daNm (kgm).
- If caster angle should be also adjusted, tighten the nuts after performing this second adjusting.

St.5. 0. 99. 10. 2 CHECKING AND ADJUSTING CASTER ANGLE

When the car is unloaded, the caster angle value should be 20' $\pm$ 45'' provided that between the R.H. and L.H. wheel the caster angle difference should not be more than 45'' (see fig. 2. 52).

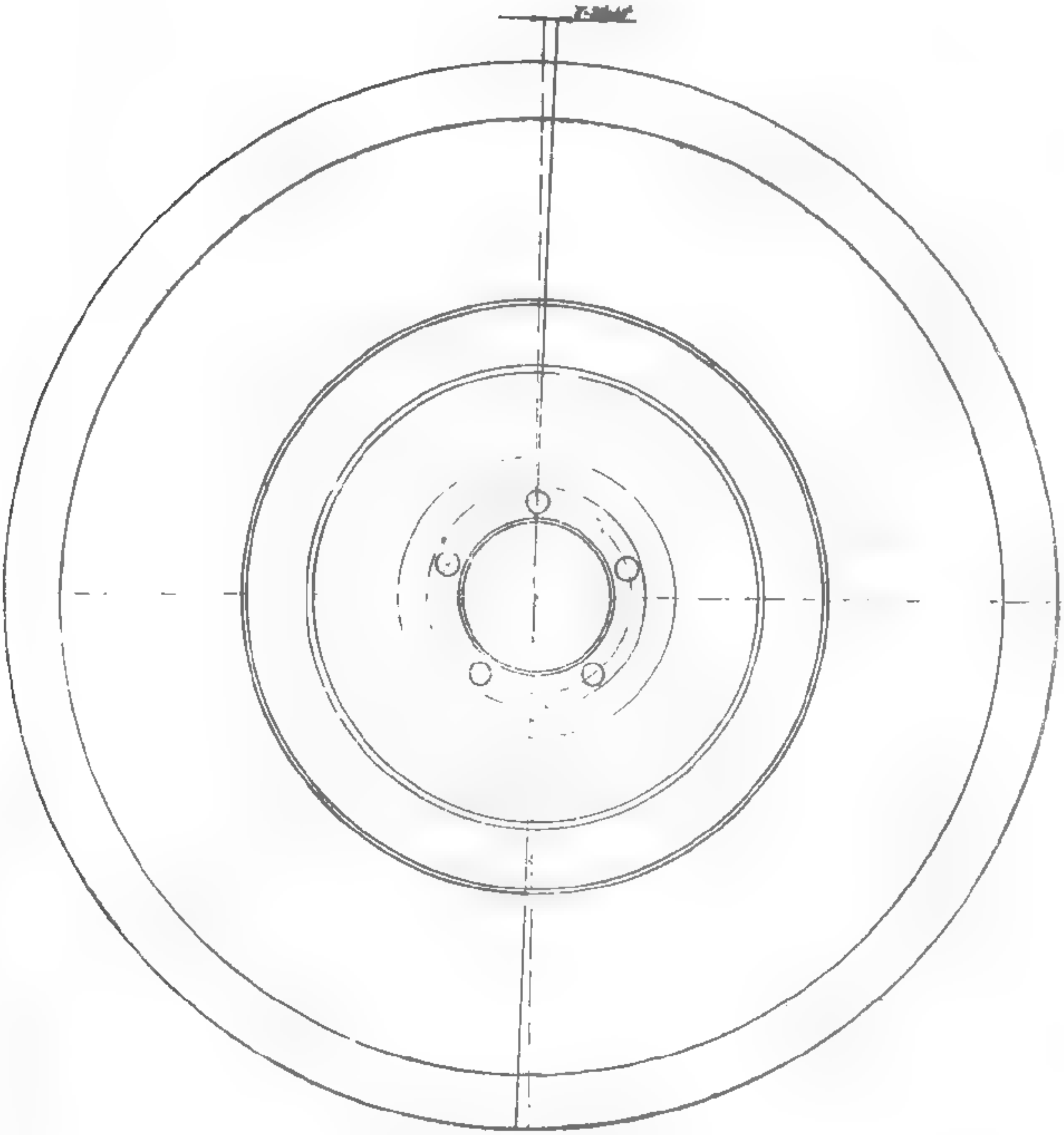


Fig. 2. 52. STEERING WHEEL CASTER ANGLE
= 20' $\pm$ 45".

- If the angle deviations are more than 1^{0}, the caster angle should be adjusted, by moving spacing plates, from front bolt to the rear one, in order to decrease the caster angle, knowing that the removing of a spacing plate of 1 mm thickness change the caster angle value with 40" (from the front to rear bolt) less, while moving the plate from rear to front bolt increases the agle value.

- After finishing the adjusting, tighten the nuts and counter nuts with a torque of 7 daNm (kgm).

St. 5.0.99.10.3 CHECKING AND ADJUSTING THE STEERING ANGLE.

- Turn steering wheel successively to the R.H. and the L.H., up to the limit the steering angle of internal wheel should be of 30^{o}, and that of external one of 26^{o} 30', with an allownce of $\pm 1^{o}$.
- If the stop screws, fastened on the car chassis, hinder the turning of steering drop arms (see fig. 2.53), unscrew the lock nuts and adjust the bolt position in order to secure for internal wheel correct value of steering angle (30^{o}).
- Perform the same adjusting for opposite wheel, turning firstly the steering wheel to the L.H., up to the limit.
- In case that the steering angle of both wheels does not enclose in the allowed values, perform another adjusting of the draglinks.

  NOTE: On adjusting steering angle by means of draglinks do not tighten draglink bolts, before a readjusting of to-in.
- When caster angle adjusting is finished, tighten the nuts of stop screws.

  Uncorrect steering angles cause car steering difficult (to great affort on steering wheel).

St. 5.0.99.10.4 CHECKING KING-PIN CAMBER ANGLE

- It is measured in the same time with the wheel camber angle and its value should be $10^{o} \pm 30'$, provided that between the R.H. and L.H. wheel the difference should not exceed 45' (see fig. 2.50).

  The value of this angle cannot be adjusted but in the limit of the wheel camber angle.

  Eventual deviations require remedyings, according to prescriptions of chapter "Repairs".

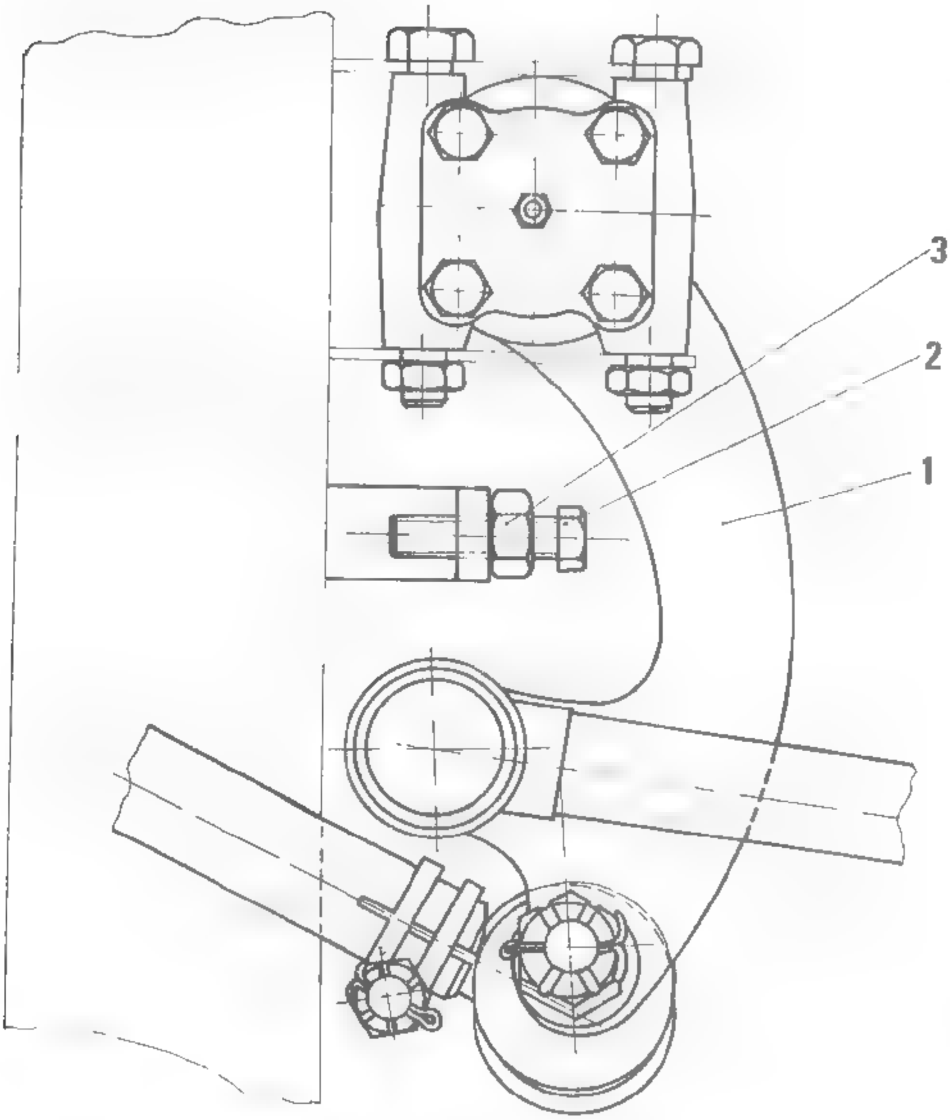


Fig. 2 53. ADJUSTING STEERING ANGLE
1. Drop arm; 2 Screw limiting steering angle; 3. Lock nut.

St. 5. 0. 99. 10, 5 CHECKING TO-IN

If steering angle adjusting was performed, it is necessary to adjust again the to-in according to Op. 5. 0. 99. 10. 0.

The driving of a vehicle having wrong adjusted angles of steering wheels leads to steering instability, tiresome car operation control feeling of "floating", difficulty in keeping the car in straight ahead running and premature wear of tyres.

2.2.6. SUPPLY SYSTEM MAINTENANCE

In the below following lines are described the supply.system maintenance operations, except those which concerne the units mounted on the engine.

OP. 2.0.11.02.0 CHANGING FUEL FILTER

- Perform this operation when the car is lifted on an inspection ramp, in order to have access from the car underside.
- Unscrew fuel pipe connections (1) - see fig.2.54.
- Unscrew bolts (2), fastening fuel filter by means of a clamping plate.
- Remove filter clamping plate and protecting gasket.
- Now, on a workshop bench, unscrew the lower filter body, remove the filtering element and replace it with a new one.
- Refit fuel filter on the car chassis, performing the operations in reverse order.
- Check pipe connections for fuel leakages.

  IMPORTANT! Pay special attention to avoid any fire danger!

OP. 2.0.11.01.0 WASHING FUEL TANK (for gasoline or Diesel fuel)

- Perform this operation in a special arranged room, considering the fire danger!
- When the fuel level indicating instrument shows that the fuel tank is empty, unscrew the fuel tank drain plug, after having previously put a collecting vessel under the tank.

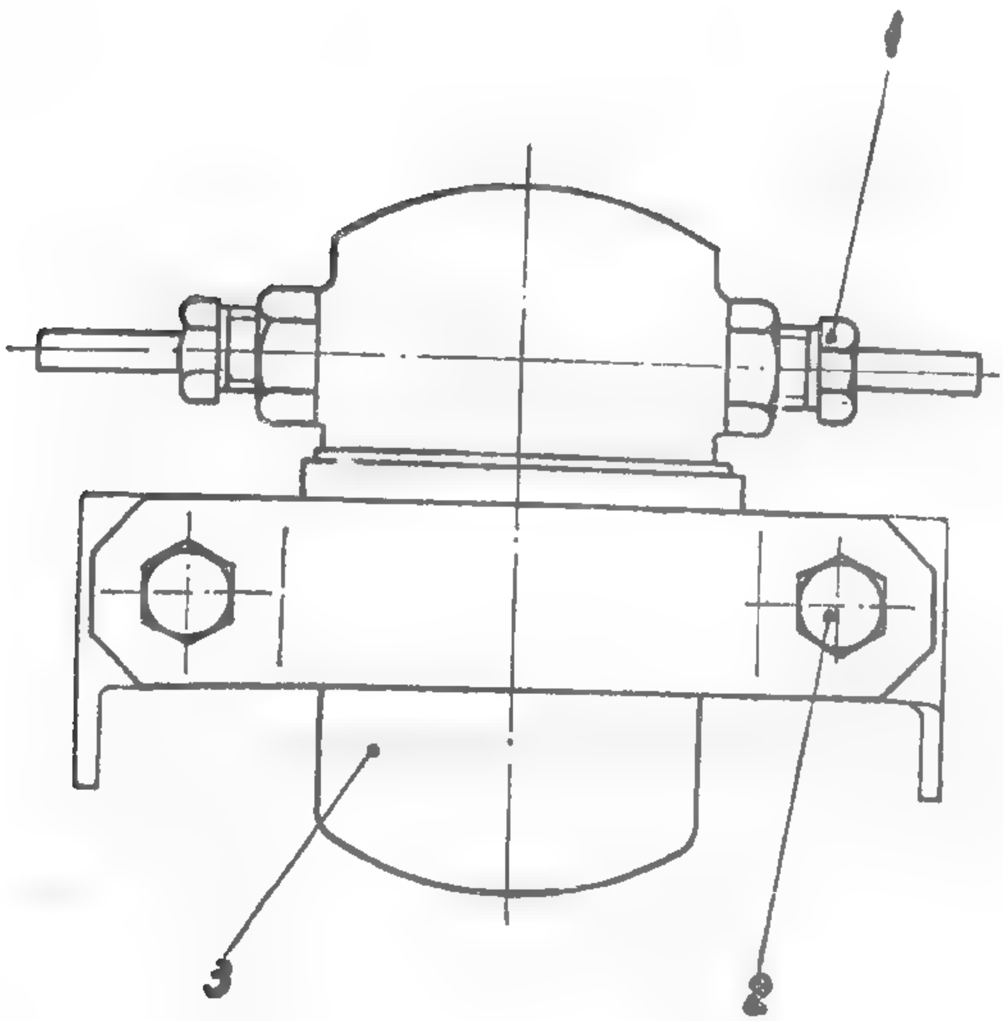


Fig.2.54. 1. Fuel line connecting nut; 2. Bolt fastening fuel filter clamping blade; 3. Lower filter body.

righten then the radiator filler cap.

OP. 2.0.13.03.0 CHANGING ANTIFREEZE FLUID

It is recommended to perform this operation at the end of autumn.

- Drain the cooling system as indicated above (Op. 2.0.13.02.0).
- Shut all the cocks and fill up the system with clean water.
- Let the engine run for 5-10 minutes and drain again the cooling system.
- Shut again all the cocks and fill up the cooling system with fresh antifreeze fluid.
- Start again the engine and, as far as the fluid level decreases, (eliminating the air from the fluid) fill up the system with antifreeze fluid, untill the fluid level in expansion vessel reaches about 75% of it, or, if the cooling system is not sealed, the fluid level should reach 10-15 mm above the radiotor core.
- Finaly, tighten the radiator filler cap.

OP. 2.0.13.04.0 DRAINING UP THE COOLING SYSTEM

- This operation is performed when the engine is not cooled with antifreeze fluid and a frost danger is possible (temperatures below $0^{o}C$).
- Drain completely the cooling system, by opening all the cocks and the radiator filler cap (the cocks mounted on cylinder head, cylinder block the hose connecting water pump with the radiator and the lower radiator basin).
- After water complete draining shut the cocks of cylinder block and lower radiator basin.

2.2.8. ELECTRICAL EQUIPMENT CURRENT MAINTENANCE

In this paragraph is described the current maintenace of electrical equipment, except the units mounted on the engine.

OP. 2.0.37.01.0 CHECKING STORAGE BATTERY CHARGING CONDITION

The storage battery charging condition is checked by measuring the electrolyte density, For this:

- Tilt backwards the R.H. passenger seat and remove the battery cover
- Wipe battery surface with a wet cloth, untill it is clean and then with a dry, clean cloth, antill the surface gets dry and clean.
- Unscrew the cell plugs and introduce in each cell the densimeter.

The electrolyte density should be tne same in each cell, namely:

Battery condition	Electrolyte density (g/cm^3)	
	At + 15°C	In tropical zones
Charged 100%	1,28	1.24
Charged 50%	1.20	1.15
Discharged	1.12	1.09

If electrolyte density of one of the battery cells is under 1.20 g/cm^3, although the electrical equipment (alternator, voltage regulator, electrical connections) are in good conditions and charge well (according to instrument indication), the battery should be taken down in order to be checked and charged in a repair workshop.

- After checking the battery, screw the plugs of each cell, wipe well the battery surface, fit back the battery cover and tilt the passenger seat in its normal position.

OP. 2.0.37.02.0 CHECKING BATTERY CONNECTION

- Tilt backwards the passenger seat and remove the battery cover from the seat support.
- Wipe firstly with a wet cloth and then with a dry one the battery surface, untill it gets clean and dry.

Inspect battery connections for oxides or slackend connections. If necessary, undo both connections and clean them and the battery terminals, using emery paper. Remove all traces of resulted powder.

- Refit connections, securing a contact on a most possible great surface; protect connections with neutral grease.

OP. 2.0.37.03.0 CHECKING BATTERY ELECTROLYTE LEVEL

- Tilt backwards the passenger seat and remove battery cover from the seat support.
- Remove the plugs of each cell and inspect the electrolyte level; do not let electrolyte level to decrease below the upper edge of rippled PVC separators. Normally, the electrolyte level should surpass with 10-15 mm the edge of separators.
- Top up electrolyte always with distilled or half distilled water, but never with acid.
- If for some reason some electrolyte was poured out, top up the battery with fresh electrolyte, having the same density as that from battery.
- Finaly, screw the cell plugs, fit the battery cover and tilt back the passenger seat.

OP. 5.0.99.08.0 CHECKING DASHBOARD INSTRUMENTS

a) Check voltage indicator when the battery is on charging stage. After some successive travels, when generally the storage battery gets discharged (specially inside the localities), check the voltage indicator which should indicated the charging stage. To judge rightly the charging condition of battery, perform electrolyte density checking, as described above (Op. 2.0.37.01.0).

b) Check fuel level gauge on filling the fuel tank. When the fuel level gauge indicates 1/2, drive to a filling station and fill the tank with 40 liters fuel. In this new situation the fuel level, gauge should indicated 1/1.

c) The fuel level alert is checked when the fuel tank is completely emptied for cleaning. On refilling the fuel level alert should switch off when about 8-10 litres of fuel were poured in the tank.

Another manner of checking fuel level alert is to empty grdually the fuel through the drain plug. When the level alert lights, going on, the fuel quantity drained drained up to complete empying should be 8-10 litres.

d) The pilot lamps of flasher lights or main driving beam should be checked normally before every departure.

e) Checking of speedometer can be carried out driving on marked roads with a constant speed of 60 km/h (36 m.p.h.). During 5 minutes will be covered a distance of 4.6-4.9 km(2,85 - 3.02 milles).At a greater speed the speedometer indicates with 6% more speed as the real speed. In order to performe a correct checking one should also take in account the rate of wear of tyres.

f) On normal engine running the oil pressure gauge should indicate a pressure of 2-4 bars (kg/cm^2), while at idle speed at least 0.5 - 0.8 bars.

g) The oil pressure alert should light on starting the engine and switch off after 2-3 seconds; if not, in case that the oil pressure gauge indicates the oil pressure existence, drive to the first SERVICE workshop for remedying the fault.

IMPORTANT:

If, on running engine there will be no oil pressure, the car should be hauled to a SERVICE workshop, for remedying the fault or the fault can be remedied on the spot, following the indications of chapter "Repairs".

h) Check the parking brake pilot lamp by pulling the brake lever, when the pilot lamp should light. On releasing the brake lever, the pilot lamp should switch off.

i) For checking hazard indicator switch on R.H., L.H., front and rear traffic indicators (flasher lamps) which should operate simultaneously.

OP. 2.0.99.12.0 ADJUSTING THE HEADLAMPS

The ARO jeep cars can be equiped with round or rectangular headlamps, provided with an adjusting device, in order to orrientate the light beam, according to loaded or unloaded car condition.

On the "F A D" rectangular headlamp (see fig. 2.55), the rocking level should be up "when the car is loaded and down, when it is unloaded.

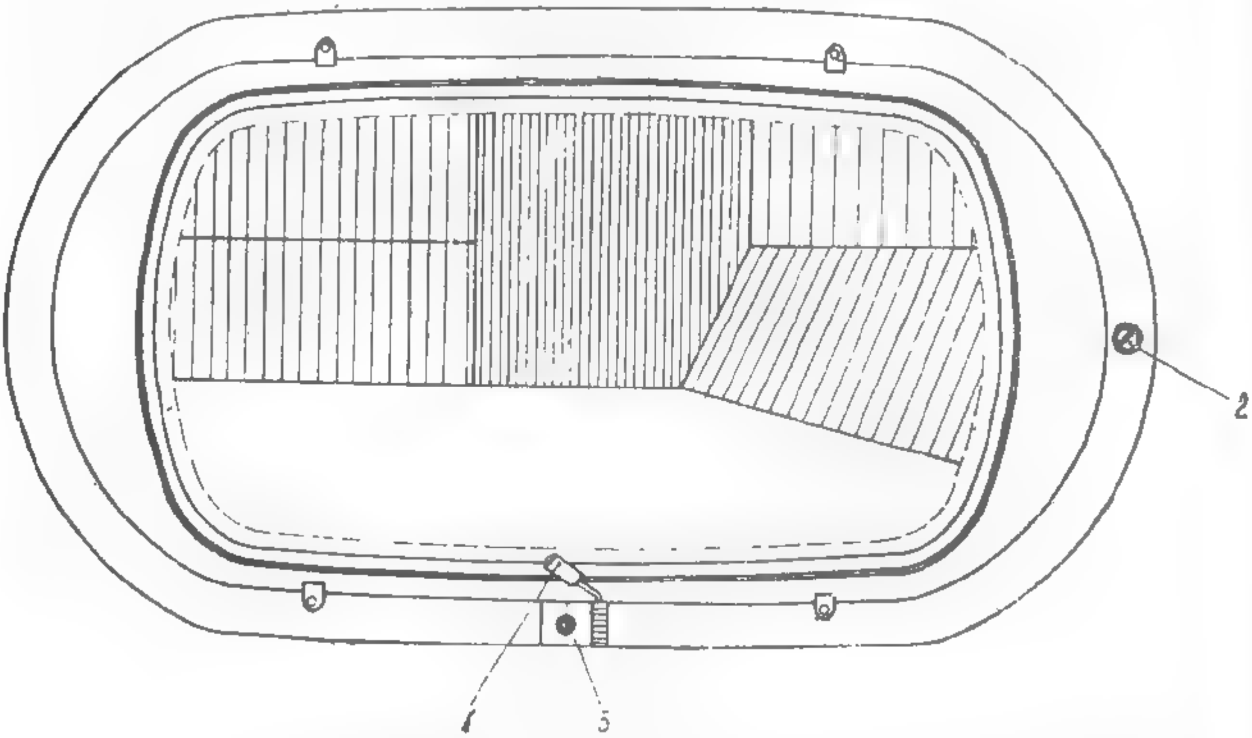


Fig. 2.55. F A D RECTANGULAR HEADLAMP
1. Headlamp rocking lever; 2. Horizontally adjusting screw; 3. Vertically adjusting screw

On the "F E R" rectangular headlamp (see fig. 2.56), the rocking lever (1) should be to the left, when the car is loaded, and to the right, when it is unloaded.

ATTENTION! Do not adjust the headlamps corresponding to unloaded condition when the car is loaded! The light beam will blind the drivers coming from opposite side, causing the danger for grave accidents.

To adjust correctly the headlamp range proceed as follows:

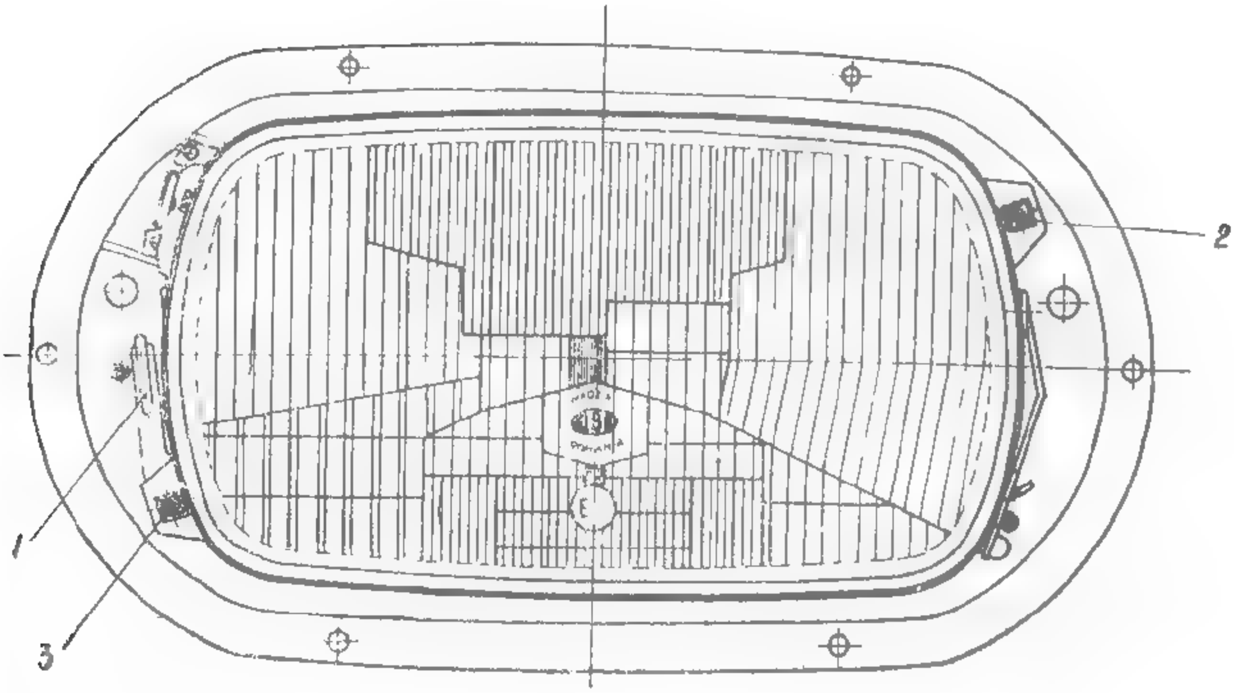


Fig. 2.56. F E R RECTANGULAR HEADLAMP
1. Headlamp rocking lever; 2. Horizontally adjusting screw; 3. Vertically adjusting screw.

- Position the vehicle, unloaded, with normal tyre pressure, on level ground, at a distance of 10 metres from a vertical white screen (a white wall, for instance), perpendicular to vehicle axis.
- Mark on the screen the distance between the headlamp axis (1140 mm), symmetrically to vehicle axis, To obtain a precise adjusting, trace firstly on the ground respective position of the vehicle wheels.
- Perform headlamp adjusting successively.
- Switch on the headlamps and check if they are both connected alike. If the two beams are not alike (one driving beam and the other one dipped), reverse the connections at one of the headlamps,
- Now, switch on dipped beam.
- The adjusting of the light beam direction, horizontally, upwards, is performed by turning the screw (2) (on the right side of the headlamps F A D and F E D or the screw (1), on the left side of the round headlamp (see fig. 2.57).

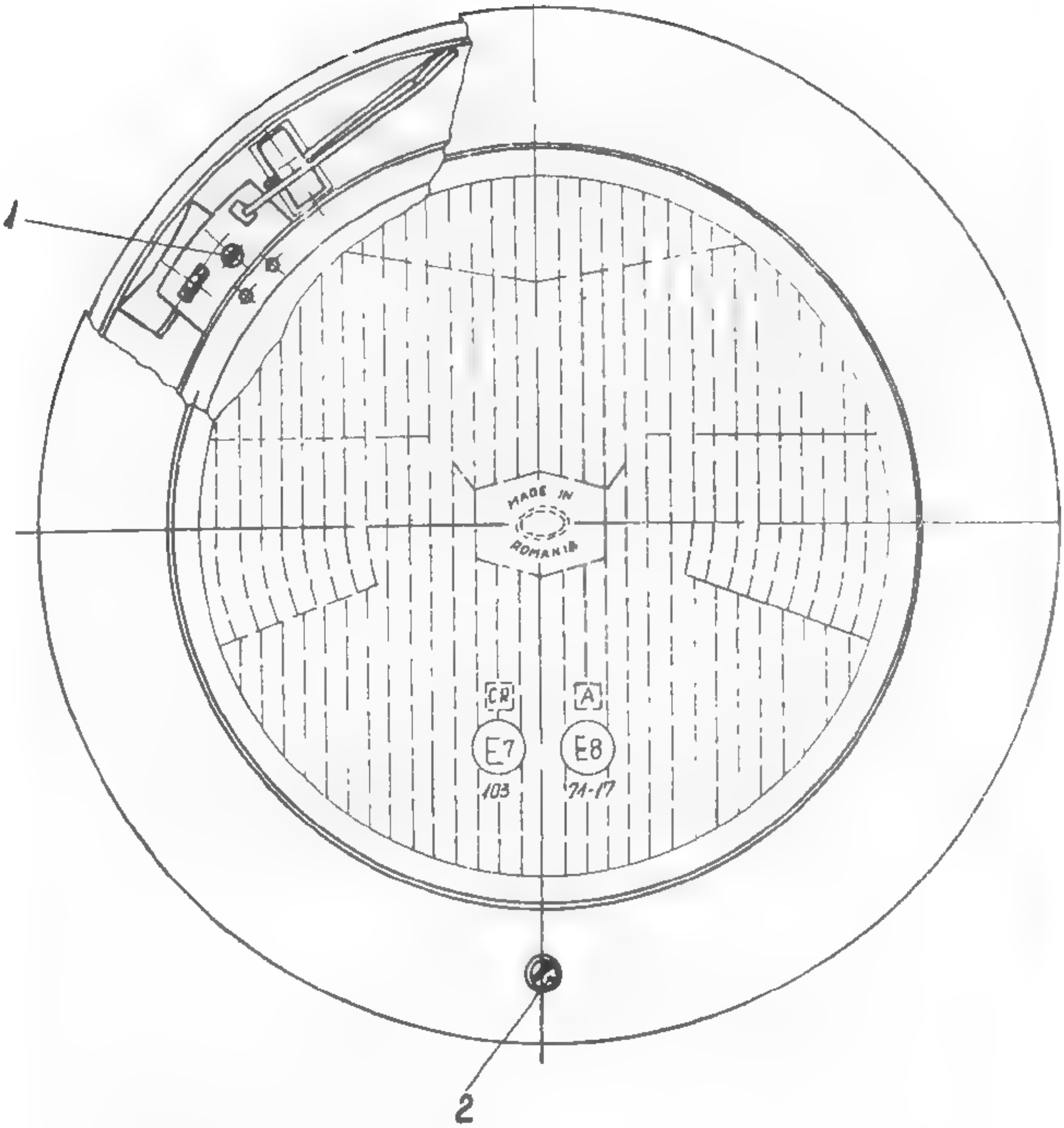


Fig. 2.57. ROUND HEADLAMP

1. Horizontally adjusting screw; 2. Vertically adjusting screw.

- Turn adjusting screw to the right or to the left untill the left angle corner of assymmetrical beam reaches the two vertical marked lines (see fig. 2.58).
- For vertical adjusting of the light beam turn on F A D headlamp the L. H. screw, while on F E R and round headlamp the lower one, adjust the beam so the height "A" of horizontal illuminated area has below indicated value, depending on vehicle model and the height of headlamp optic axis:

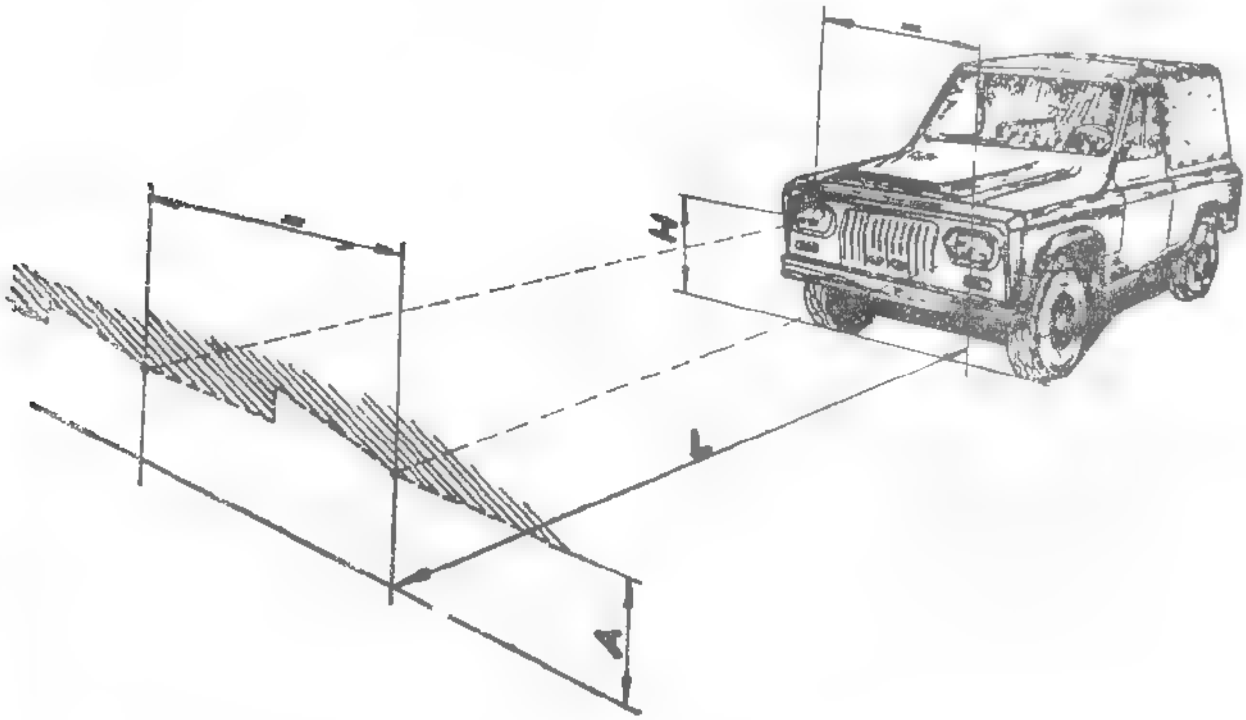


Fig.2.58. HEADLAMP BEAMS CORRECT POSITION

Vehicle model	Height " A "
ARO 240, 242 and 243	H - 280 mm
ARO 241 and 244	H - 150 mm
ARO 320	H - 290 mm

- Perform the headlamps adjusting after each bulb changing.

2.2.9. MAINTENACE OF REAR AND FRONT SUSPENSION

OP. 2.0.29.02.2 TEGHTENING NUTS OF THE REAR AXLE SPRING U-BOLTS

- Slacken the counter nuts of the U-bolts, which fasten rear axle on the rear leaf springs.
- Using a torque wrench, adjusted for a torque of 4.9 ± 0.25 daNm (kgm) check the tightening of U-bolt nuts and, if necessary tighten nuts with this torque.

- After tightening counter nuts, clean the thread of U-bolts by means of a wire brush, apply on thread some fluid securing threaded connections (such as LOCKTITE or OMNIFIT) and tighten then the conter nuts, by means of torque wrench, adjusted vor the same torque (4.9 ± 0.25 daNm).

OP. 2.0.29.03.0 CHECKING PLAYS OF STEERING KNUKLES

- Lift successively, by means of a jack, the R.H. and L.H. front wheel and check manually if both wheels have no axial or radial play.
- Now, getting access from underside of the car check if eventual play results from the wheel bearing or from the steering knukles. In case that there are plays in the steering knukles, in the lower or upper control arm, perform necessary repair according to indications of chapter "Front suspension repairs".

OP. 2.0.29.04.0 CHECKING FRONT AND REAR SUSPENSION

- Lift the car on an inspection ramp and check from underside of the car the locking of all bolts fastening the suspension control arms, as well as the tightening of the shims for adjusting steering angles.
- Check correct location of suspension coil springs and intergrity of upper and lower rubber bump stops. In case of faults, perform necessary remedying according to indications of chapter "Front suspension repairs".
- Check correct location of rear leaf springs and their fastening on chassis.The springs should not have lateral or longitudinal displacements, both situations showing damaging of some assebly components.
- Check for fastening of shock absorbers and for integrity of spring rubber pads.
- In case of faults, permorm necessary remedying according to indications of chapter "Rear suspension repairs".

2.2.10. OTHER MAINTENANCES

OP. 2.0 99.05.0 CHACKING BOLTS FOR CORRECT TIGHTENING AND SECURING

Perform checking and eventual retightening, with prescribed torque, of bolts, nuts and counter nuts of below indicated assemblies:

TIGHTENINGS ON CURRENT MAINTENANCE

TABLE VII

Key No	The place where should be checked the tightening	Tightening torque (daNm)	(ft. lbs)
1.	Gearbox fastening on clutch housing	7.00 - 7.50	50.6 - 54.2
2.	Transfer box fastening on gearbox	7.00 - 7.50	50.6 - 54.2
3.	Clut housing fastening on cylinder block	5.00 - 6.00	36.1 - 43.4
4.	Exhaust pipe fastening on exhaust manifold (L 25)	3.50 - 4.50	25.3 - 32.6
5.	Exhaust manifold fastening on cylinder block (L 25)	3.50 - 5.00	25.3 - 36.1
6.	Inlet manifold fastening on L 25 engine cylinder block	3.50 - 5.00	25.3 - 36.1
7.	Exhaust pipe fastening on exaust manifold (D 127)	4.50 - 5.00	32.6 - 36.1
8.	Exhaust manifold fastening on D 127 engine cylinder block	4.50 - 5.00	32.6 - 36.1
9.	Inlet manifold fastening on D 127 engine cylinder block	4.00 - 5.00	28.9 - 32.6
10.	Carturettor fastening on inlet manifold	0.70 - 0.80	5.6 - 5.8
11.	Water pump fastening on cylinder block	2.50 - 3.50	18.2 - 25.3
12.	Thermostat housing fastening on cylinder block	1.70 - 2.50	12.3 - 18.2
13.	Alternator support fastening on cylinder block	6.50 - 8.50	48.0 - 61.5
14.	Starting motor fastening on ARO L 25 engine	1.70 - 2.00	12.3 - 14.4
15.	Starting motor fastening on ARO D 127 engine	1.70 - 2.20	12.3 - 15.9
16.	Oil filter fastening on ARO L 25 engine block	2.50 - 3.50	18.2 - 25.3
17.	Cylinder head fastening on engine block	2.50 - 3.50	18.2 - 25.3
18.	Diesel fuel filter fastening on D 127 engine	3.40 - 4.50	24.6 - 32.6

Key No.	The place where should be checked the tightening	Tightening torque (daNm)	(ft. lbs)
19.	Injection pump fastening on D 127 engine block	3.50 - 4.50	25.3 - 32.6
20.	Ignition distributor fastening on ARO L 25 block	1.70 - 2.50	12.3 - 18.2
21.	Fuel pump fastening on engine block	1.70 - 2.50	12.3 - 18.2
22.	Fastening of upper control arms on chassis cross member	6.50 - 8.00	48.0 - 57.8
23.	Fastening of lower control arms on chassis support	7.00 ± 0.50	50.6 ± 3.6
24.	Fastening of wheels	14.00 ± 1.00	101.0 ± 7.2
25.	Fastening of front and rear shock absorbers	2.50 - 4.00	18.2 - 28.9
26.	Fastening of rear axle U-bolts	4.90 ± 0.25	35.4 ± 1.8
27.	Engine bonnet latch fastening	2.50 - 4.00	18.2 - 28.9
28.	Fastening of lateral front and rear doors hinges	1.70 - 2.50	12.3 - 18.2
29.	Fastening of rear door hinges on ARO 243 car	1.70 - 2.50	12.3 - 18.2
30.	Fastening of lateral door catches	3.50 - 4.50	25.3 - 32.6
31.	Fastening of rear door clach on ARO 243 car	3.50 - 4.50	25.3 - 32.6
32.	Fastening of rear door guide on ARO 243 car	3.50 - 4.50	25.3 - 32.6
33.	Fastening of upper tailgate catch	3.50 - 4.50	25.3 - 32.6
34.	Fastening of car body on chassis	3.00 - 4.00	21.7 - 28.9
35.	Fastening of goods bucket on chassis (ARO 320)	3.50 - 4.50	25.3 - 32.6

NOTE: Check fastening of assemblies for securing with split pins.

SPLIT PIN SECURED PLACES TO BE CHECKED ON CURRENT MAINTENANCE

TABLE VIII

Key No.	The place where securing is to be checked	Split pin dimension (Ø x L)
1.	Engine fastening on chassis	2.7 x 25 (mm)
2.	Steering gearbox fastening on chassis	2.0 x 25
3.	Steering pivot case fastening on chassis	2.0 x 25
4.	Steering drop arms fastening	5.0 x 50

Key No.	The place where securing is to be checked	Split pin dimensions (Ø x L)
5.	Nuts fastening the draglinks	3.2 x 25
6.	Nuts fastening draglink clamps	2.0 x 25
7.	Nuts securing fulcrum pins on connecting tie rod	3.2 x 28
8.	Nuts fastening upper and lower steering shaft	1.6 x 22
9.	Nuts fastening lower control arm on steering knukles	2.0 x 25
10.	Propeller shaft flange fastening	Lock plates
11.	Fastening of steering shaft flanges on flexible coupling	Lock plates

OP. 1.0.09.03.0 CHECKING FOR OIL, BRAKE FLUID, COOLING FLUID AND FUEL LEAKEGES

After coming with the car from a travel, which brought it in a steady state regime, lift the car on an inspection ramp and inspect the places where could be traces of wear or fluid leakages. Perform inspection from underside of the car.

- Check rear axle for brake fluid leakages (radial traces on wheel rim and tyres), inspecting connection joints between brake pipes and brake cylindres. Check also for oil leakages through differential filler and drain plugs, and also on propeller shaft flange.
- Check fuel tank for fuel leakages through the filler cap, the drain plug, fuel filter and fuel pipes connections.
- Check the engine for oil leakages, inspecting the rear bearing, jointing area between the oil sump and cylinder block, the area of oil filter fastening, the gearbox and transfer box plugs, the jointing area between gearbox and transfer box, the propeller shaft flanges, the fuel pump fastening area.
- Getting access under the engine bonnet, check if there are no leakages on brake & clutch master cylindres, on compensating reservoirs, on connecting pipes with the clutch slave cylinder.

- Check front differential for oil leakages near the covers, near axle drive shafts, at longitudinal propeller shaft flange.
- Check the front wheels for leakages, similarly as the rear wheels.
- Check cooling system for fluid leakages, inspecting all hose connections between water pump, thermostat, inlet manifold and heating system.
- On Diesel D 127 engine check specially the high pressure fuel pipe connections, as well as all pipe connections with the fuel pump, fuel filter, fuel tank, etc.

  In case that leakages were found but do not disappear after tightening respective connection element, perform necessary remedying according to indications given in the chapter "Repairs".

OP. 2.0.99.14.0 BODY MAINTENANCE

- Inspect for rest traces the body underside (mudguards, lower cowl and the body floor pan).

  In case that due to various causes the antirust and antiphonic paint coat was removed from the body steel sheet and rusted areas have appreared, these should be cleaned with abrasives, up to clean metal surface, applying after that a red lead minium prime paint coat (or equivalent prime paint). After 24 hours should be applied an antiphonic paint coat.
- If on upper body surface will appear deep scratches or paint exfoliations,proceed similarly as with the body underside, with the difference that the paint applied over the prime paint should have the body colour. This paint is supplied for each ARO vehicle, together with standard accessories. If it will be necessary more paint, get any paint equivalent to "EVERGLOSS" paints.

  The repainted area should be extend, after roughing adjacent areas with fine abrasive paper, up to jointing lines or borders of respective body component.
- Perform repainting by means of a paint spray gun. Protect body areas, which should not be painted, covering them with adhesive paper bands.
- Let dry the painted surface for 24 hours in a dust-free room.

OP. 2.0.99.02.0 REMOVING PROTECTIVE COAT

- The protective coat (a waxlike stuff, called "Procerin") can be removed, either with organic solvents (white-spirit, etc.) or with a common detergent solution.
- In both cases take special attention on removing the protective coat around the instruments and electrical connections, in order to avoid any short-circuit, or, on using organic solvents, any fire danger. Such areas should be cleaned using cloths weted with deconservant agent.

  In any case start the engine only after complete dry wiping of cleaned areas.

OP. 5.0.99.04.0 OPERATING INSPECTION ON DELIVERY OF STORED VEHICLE

- Check resistance of seals.
- Check the presence of tools outfit and spare parts of the vehicle, brought for maintenance.
- Check and top up:
  - Oil level in oil sump and air cleaner.
  - Oil level in gearbox, transfer box, front and rea differential and stearing gearbox.
  - Brake fluid level in brake clutch master cylinders.
  - Cooling fluid level in radiator.
- Check the presence of eventual leakages of oil, water, brake fluid, fuel.
- Check storage battery charging condition.
- Turn engine crankshaft 2 - 3 times by means of starting handle.
- Check air pressure in the 5 tyres.
- Check correct operation of:

  the engine, at idle speed and in full load.
- Dashboard instruments.
- Headlamps, front and rear flasher lamps, stop tail lamp, etc,
- The horn.

- Windscreen wiper and washer.
- Main and parking brake systems.
- Steering mechanism.
- Door locks.

CHAPTER III. POSSIBLE FAULTS AND THEIR CAUSES

During the vehicle traffic, and in the present case, the ARO vehicles, can occur various faults, due to vehicle traffic normal wear of components, or as a result of some hidden flaws of the components and units of the vehicle. In order to facilitate the faults remedying, below will be presented possible faults, their causes and the manner of intervention.

ATTENTION: Always begin by shooting firstly the causes more simple when occur difficulties on starting or operating the vehicle. It is little possible that in case of a correct vehicle maintenance, the fault cause results from a faulty part or unit. For instance: discontonous engine running can be sooner caused by an impurity in the carburettor main jet as by a fault of timing system.

In many cases the faults are caused by external factors, such as road conditions, fuel changing or even driver's ability.

It is useful to intervene whenever it is observed that the vehicle performances are below the normal and not to let untill the situation grows worse and occurs an irremediable damage of certain parts and units.

3.1. THE FAULTS WHICH AFFECT THE VEHICLE DRIVING POWER

The vehicle cannot move without a driving power. It will have reduced performances if its engine does not normally run.

3.1.1. FAULTS OF VEHICLES EQUIPPED WITH ARO L-25 ENGINE

3.1.1.1. ENGINE DOES NOT START ON SWITCHING ON

3.1.1.1.1. STORAGE BATTERY IS DISCHARGED

- On switching on the starting motor, the vehicle lights grow dim or even die out.

Remedies:

- Check connections on battery terminals (Op. 2.0.37.02.0)
- Check connections on starting motor terminals (Op. 2.0.37.04.0)
- Check ground connection of starting motor (Op. 2.0.37.09.0)
- Check storage battery for its charging condition (Op. 2.0.37.01.0)
  If the battery is discharged or defective, take it down from the vehicle and charge it (Op. 2.0.37.07.0) respectively replace it.

3.1.1.1.2. FAULTS ON ELECTRICAL WIRING

On switching on the starting motor the vehicle lights do not light. The causes should be sought on disconnected or broken electrical connections, on faulty starter switch or faulty starter relay.

For this:

- Check supply circuit up to starting motor (Op. 2.0.37.10.0)
- Check and eventually replace the starter switch (Op. 2.0.37.11.0)
- Check startingmotor without takingit down from the engine (Op. 2.0.37.05.0).
- If necessary, take starting motor down (Op. 2.0.37.12.0) and preform a general maintenance inspection (Op. 4.0.37.06.0) or, if some faults will be found, perform their remedying (Op. 4.1.37.13.0).

3.1.1.1.3. FAULTS OF MESHING BETWEEN ELECTROMOTOR DRIVE AND FLYWHEEL

On switching on the starting motor there are heard the start-up of engine and, eventually, metalic, anormal noises, caused by bad Bendix drive meshing. Turn

crankshaft with $30-45^{0}$ and try a new start-up. There can appear two situation:
a) The engine starts normally: you can draw the conclusion that the flywheel ring gear has some teeth broken. b) Or the trouble occurs again, when the Bendix drive is faulty or the flywheel ring gear has all teeth broken.

In this case:

- Take downstarking motor from emgine (Op. 2.0.37.12.0) and perform remedying of Bnedix drive (Op. 4.1.37.13.1).
- Take down engine from the vehicle (Op. 2.0.10.01.0), after having previously taken the gearbox down from engine (Op. 2.1.10.01.1).
- Put then the engine on a stand or special D.5 device, for setting and fastening engine on dismantling.
- Dismantle clutch housing (Op. 4.1.10.01.2) and then the clutch from the flywheel (Op. 4.1.16.02.0).
- Remove flywheel from the crankshaft (Op. 4.1.05.03.0).

  Now you can perform, stricly speaking, the replacing of flywheel ring gear (Op. 4.1.05.03.1).

3.1.1.2. THE ENGINE IS CRANKED BY STARTING MOTOR BUT DOES NOT START.

3.1.1.2.1. FAULTS IN IGNITION SYSTEM.

In this situation there may be various causes and should be examined systematically, Namely, it may be: interruped ignition wires; interrupted circuit between ignition coil and ignition distributor; fouled spark plugs, decalibrated plugs or having fissured insulation; ignition distributor detuned or having faulty components; ignition coil burned out (as a result of stopped engine without switching off the current). To remedy the trouble:

- Check ignition wires current leakages (Op. 2.0.01.18.0).
- Check circuit between ignition coil and ignition distributor (Op. 2.0.37.15.0).
- Check, and eventually adjust air gap of spark plugs (Op. 2.0.01.07.0).

- Replace faulty spark plugs (Op. 0.01.19.0).
- Check, and if faulty, replace the ignition distributor condenser (Op. 2.0.37.16.0).
- Check, and eventually adjust contact-breaker gap of ignition distributor (Op. 2.0.01.09.0).
- Clean ignition distributor breaker points, if they are oxidated (Op.2.1.01.23.0).
- Check ignition distributor cover for fissures and clean it (Op. 2.0.01.24.0).
- Check ignition distributor rotor and if faulty, replace it (Op. 2.0.01.25.0).
- Check ignition coil and if faulty, replace it (Op. 4.1.37.18.0), performing its checking on a bench, after having taken it down from the vehicle (Op. 2.0.37.17.0).

3.1.1.2.2. TROUBLES OF FUEL SUPPLY SYSTEM

The engine cannot start if there is no fuel supply (or the engine is flooded). The trouble shooting is performed successivley;

- Check firstly on fuel level gauge if there is fuel in the tank.
- If yes, check carburettor main jet for clogging.
  Check spark plugs for degree of wetting.
- Check fuel pump operation (Op. 2.0.01.26.0). If the pump does not supply fuel, clean the pump filter (Op. 2.0.01.12.0).
- Check fuel lines for continuity and tightness (Op. 2.0.11.06.0).
- Check and eventually replace fuel pump diaphragm (Op..2.1.01.26.1).
- Take down fuel pump from the engine (Op. 2.0.01.27.0) and perform its general overhauling, replacing worn parts (Op. 4.1.06.01.0). In case that the fuel pump supplies, go on with trouble shooting, as follows:
- Check and eventually clean carburettor inlet filter (Op. 2.0.01.14.0).
- Check and eventually clean the carburettor main jets (Op. 2.0.01.15.0).
- Check spark plug heads in order to see if engine is not flooded (Op. 2.0.36.01.0). If a spark plug is wet, dry all spark plugs and perform engine starting as for a flooded engine, i.e. with accelerator pedal in its middle position, without actuating the accelerator pump and switching on the switchin on the starting motor many times, untill you will get fuel elimination from the engine and the engine starts.

Check air cleaner for clogging and, if necessary, clean it (Op. 2.0.08.03.0).

- Check muffler rear pipe for clogging with mud, and if necessary, clean it (Op. 2.0.12.01.0).
- Check if there is no water in the fuel supply system (Op. 2.0.11.05.0).
- Check carburettor float chamber; if engine got flooded, check if float assy position is correct (Op. 2.1.15.02.2).
- Check carburettor needle valve tightness on its seat or eventually if the neadle valve seat is not clogged (Op. 2.1.15.02.1).
- Check air duct tightness between carburettor and cylinder head (if there is no air infiltration) (Op. 2.0.08.02.0).

3.1.1.3. THE ENGINE TURNS SLOWLY AND DOES NOT START

On switching on the starting motor the vehicle lights grow much dim and the engine turns slowly, irregularly, without be able to start.

The cause can be: discharged storage battery, loosened electrical connections between starting motor and battery, insufficient battery electrolyte level or engine oil viscosity too high. To remedy the trouble:

- Check battery electrolyte level (Op. 2.0.37.03.0).
- Check battery charging condition (Op. 2.0.37.01.0) and, if necessary, charge it (Op. 4.0.37.07.1).
- Check connections on battery terminals (Op. 2.0.37.02.0)
- Check connections on starter relay (Op. 2.0.37.08.0).
- Check connections on starting motor (Op. 2.0.37.09.0).
- Check engine oil viscosity and eventually replace it (Op. 2.0.01.28.0).

3.1.1.4. ENGINE RUNNING INTERRUPTED BY MISFIRING

- Misfirings can occur in exhaust muffler, due to ignition faults, incorrect air-fuel mixture, disadjusted advanced ignition or jammed exhaust valves (lack of clearance between valve steam 'and guide).

Misfiring can also occur in carburettor, due to lean mixture, wrong heat range of spark plugs or sparks of low intensity. There can also be a mechanical cause, i.e. incorrect clearance of valves.

To remedy misfirings in exhaust muffler:

- Chack ignition system operation,by observing the spark of ignition distributor center plug as well as of spark plugs (Op. 2.0.36.02.0); in case that the sparks are intermittent, check and eventually adjust the distributor breaker gap (Op. 2.0.01.09.0) or clean oxidated breaker points (Op. 2.1.01.23.0).
- If the spraks are still intermittent, check engine electric equipment for current supply (Op. 2.0.37.15.0). Namely:
- Check advanced ignition (Op. 2.01.01.13.0).
- Check exhaust valve clearance (Op. 2.1.01.08.2).
- Check exhaust valve condition (Op. 2.1.01.30.1), after having previously taken down cylinder head cover (Op. 2.0.01.21.1), rocker arm shaft assy (Op. 2.1.01.29.0) and cylinder head (Op. 2.1.01.30.0). To remedy misfirings in carburettor, perform following operations:

3.1.1.5. THE ENGINE STARTS AND THEN STOPS

- Check fuel pump operation (Op. 2.0.01.26.0). In case that fuel pump supply is not satisfactory, perform remedyin in following order:
- Clean fuel pump inlet filter (2.0.01.12.0).
- Check fuel pump diaphragm (Op. 2.1.01.26.1) or take down the pump from the engine (Op. 2.0.01.27.0) and perform its complete overhauling (Op. 4.1.06.01.0).
- Check and eventually clean the carburettor inlet filter (Op. 2.0.01.14.0).
- Clean carburettor main jets (Op. 2.0.01.15.0).
- Check and eventually adjust fuel level in carburettor float chamber (Op. 2.1.15.02.2), after having previously removed carburettor adapter and carburettor cover (upper body) (Op. 2.0.01.15.1 and 2.1.15.02.0). Clean then the needle valve seat (Op. 2.1.15.02.1).
- Check the spark plugs and eventully replace them if their heat range is wrong (Op. 2.0.01.07.0).
- Check the spark on ignition distributor center plug and on the spark plugs (Op.2.0.36.02.0). If the spark is weak, check and eventually clean the ignition breaker points. Check also ignition distributor cover for fissures and clean it (Op. 2.0.01.24.0).

- Check also H.T. leads.
- Check inlet valve clearance (Op. 2.1.01.08.2).

In case that the trouble cause will be not found in supply or ignition system, check inlet valve condition (Op. 2.1.01.30.2), after having previously removed the cylinder head cover (Op. 2.0.01.21.1).

3.1.1.5. THE ENGINE STARTS AND THEN STOPS

This trouble occurs most frecvently, due to fuel shortage or insufficient fuel supply. To remedy the trouble:

- Check fuel presence in the fuel tank, by means of fuel level gauge (on dashboard) - (Op. 2.0.11.04.0).
- Check fuel pump operation (Op. 2.0.01.26.0). In the fuel supply is insufficient, perform the following interventions:
- Check and eventually clean the fuel pump inlet filter (Op. 2.0.01.12.0).
- Check continuity and tightness of fuel pipes, leading to fuel tank (Op. 2.0.11.06.0).
- Check fuel pump duaphragm and, eventually, replace it (Op. 2.1.01.26.1)
- Take down fuel pump from the engine (Op. 2.0.01.27.0) and perform its general overhauling, replacing worn out components (Op. 4.1.06.01.0).

In case that the fuel pump supply is satisfactory, the trouble should be seeked beyond the fuel pumpl, respectively:

- Check and eventually clean the carburettor inlet filter (Op. 2.0.01.14.0).
- Check and eventually clean the carburettor main jets (Op. 2.0.01.15.0).
- Remove carburettor adapter (2.0.01.15.1) and carburetor cover (Op. 2.1.15.02.0), inspecting float assy position in the float chamber (Op. 2.1.15.02.2) and clean the needle valve seat (Op. 2.1.15.02.1). In case that the needle valve is jamming,due to its wear, remedy it by grinding its point or replace needle valve (Op. 2.1.15.02.3).
- Check if there is no water in fuel (Op. 2.0.11.05.0).

3.1.1.6. THE ENGINE RUNS ONLY WHEN CHOKE IS PULLED

The trouble can occur due to carburation troubles or mechanical causes. Perform investigations in the following order:

- Check and eventually clean the idling jets (Op. 2.1.15.03.0), after having previously removed the carburettor adapter (Op. 2.0.01.15.1).
- Adjust the idle speed running (Op. 1.0.01.22.0).

Mechanical causes occur in the timing gear, in the area of valves.

- Check clearance between rocker arms and valves (Op. 2.1.01.08.2).
- Check inlet and exhaust valves condition (Op. 2.1.01.30.1), after having previously removed cylinder head cover (Op. 2.0.01.21.1), rocker arm shaft (2.0.01.29.0) and cylinder head (Op. 2.1.01.30.0).
- Check if there are broken springs or valves jammed in their guides.

3.1.1.7. THE ENGINE HAS NO OUTPUT

The trouble occurs due to: <u>defective supply</u> of fuel mixture, from carburettor, whose throttle butterflies do not open completely, due to mechanical causes; overrich fuel mixture (much black smoke at the muffler, because the choke is jammed or carburettor is flooded; the engine is too hot, due to lack of cooling water or there is too much lime scale in the engine cooling system, causing knocks on angine running; wrong clearances of engine valves; clogged exhaust system.

In case of overrich fuel mixture, causing black smoke at muffler:

- Check choke for correct operation (Op. 2.1.15.04.0).
- Check carburettor float chamber for flooding (Op. 2.1.15.02.3).
- Check needle valve wear (Op. 2.1.15.02.1).

In the other situations perform following operations, untill the trouble is found:

- Check clearance of valves (Op. 2.1.01.08.2).
- Check exhaust system for clogging with mud (Op. 2.0.12.01.0).

- Check correct operation of throttle control (Op. 2.0.11.07.0).
- Take carburettor down from the engine (Op. 2.1.15.01.0) and check control mechanism of throttle butterflies (Op. 2.1.15.05.0).

If on running engine occur knocks, check cooling fluid level in the cooling system (Op. 2.0.13.01.0); check cooling system for scale deposit, which should be removed, as described in Op. 2.0.13.02.0..

3.1.1.8. NOT ALL ENGINE CYLINDERS ARE OPERATIONG

This trouble is detected through distinctive noise, as well as through the lack of engine power. The possible causes can result from respective cylinder or from ignition problems: fouled spark plugs or having fissured H.T. insulation (ground leakages); faulty ignition H.T. wires (interruped or having fissured insulation, causing ground leakages); ignition distributor cover fissured near the plug of faulty cylinder (ground leakages). It can be also a mechanical trouble, as: exhaust valve jammed in its shut position, displaced or bent valve push rod; exhaust valve spring broken, so that the valve is always open; broken piston.

Perform checking and remedying in following order:

- Check respective spark plug and, eventually, replace it (Op. 2.1.01.31.0).
- Check H.T. ignition wires (Op. 2.0.01.18.0).
- Check and clean ignition distributor cover (Op. 2.0.01.24.0).
- Check inlet valves condition (Op. 2.1.01.30.2).
- Check exhaust valves condition (Op. 2.1.01.30.1).
- Inspect, and if broken, replace the valve springs (Op. 2.1.03.01.0).
- Check respective piston and, if broken or faulty, perform engine overhauling, with faulty piston replacing (Op. 4.1.04.02.1).

3.1.1.9. THE ENGINE RUNS ONLY WHEN THROTTLE BUTTERFLIES ARE OPEN.

This trouble can occur when the idle jets are clogged, the idle speed operation is out of order, air inleakage into inlet system or overrich mixture results from carburettor.

Perform successively the following checkings and remedyings:

- Check and clean idle speed jets (2.1.15.03.0).
- Check inlet system for air inleakages (Op. 2.0.08.02.0) and eventually replace inlet manifold gasket (2.1.08.02.1).
- Check air cleaner for clogging (Op. 2.0.08.03.0).
- Check carburettor float chamber (Op. 2.1.15.02.2)
- Check if needle valve shuts the fuel supply, performing precursory works, indicated in respective operations.

3.1.1.10. THE ENGINE DOES NOT STOP ON SWITCHING OFF THE CURRENT

It happens that, allthough the current is switched off. the engine continue to run, irregularly, due to self-ignition, due to too hot spark plugs, engine overheating or wrong clearances of exhaust valves. To remedy the trouble:

- Check the heat range of spark plugs on the engine (Op. 2.0.01.07.0).
- Check the fan V-belt tension (if it slips) (Op. 2.0.01.10.0),
- Check, and eventually top up the fluid in the cooling system (Op. 2.0.13.01.0).
- Remove scale deposit in the cooling system, if it is the case (Op. 2.0.13.02.0).
- Check thermostat for correct operation (Op. 2.0.13.05.0).
- Adjust clearance of exhaust valves (Op. 2.1.01.08.2).
- Clean and remove carbon deposit from cylinder head (Op. 2.1.03.02.0). They cause hot points for self-ignition.

3.1.1.11. THE ENGINE KNOCKS ON RUNNING

The engine knock (detonation) is a premature ignition of the fuel mixture, the burning front starting from one or many "hot points", existing in the combustion chamber. It appers through a distinctive noise (very sharp, as prodused by metallic blows in the cylinder head) and lack of engine power.

The causes can result from a too great ignition advance, from carbon deposit in the combustion chamber (on valves and walls), from overheated engine, from the fuel having octane number inferior to the correct one or from a too lean mixture.

The shooting of possible causes and their remedying is performed in the following order:

- Check and eventually adjust octane selector (set spark) (Op. 2.0.01.13.0).
- Check fan V-belt for correct tension (Op. 2.0.01.10.0).
- Check cooling fluid level in the radiator (2.0.13.01.0).
- Check thermostat for correct operation (2.0.13.05.0).
- Check and eventually remove scale deposits from cooling system (Op. 2.0.13.02.0).
- Drain completely the fuel tank and fill it with new fuel, having correct octane number; on this occasion remove water and settlings from the fuel tank, washing it after that (Op. 2.0.11.01.0).
- Check and clean carburettor main jets (2.0.01.15.0).
- Check fuel pump operation (2.0.01.26.0) and if its supply is not sufficient, check its inlet circuit (2.0.11.06.0), check and clean its inlet filter (Op. 2.0.01.12.0); check and, if necessary, replace fuel pump diaphragm (Op. 2.1.01.16.1); finaly, if necessary, perform complete overhauling of the fuel pump.
- If fuel pump supply is sufficient, seek the trouble cause between the fuel pump and carburettor, checking and cleaning its inlet filter (Op. 2.0.01.14.0).
- Check carburettor needle valve (Op. 2.1.15.02.1).
- Check fuel level in the float chamber (Op. 2.1.15.02.2).
- Clean carbon deposit from spark plug heads (Op. 2.0.01.07.0); replace spark plugs if their heat range is not adequate (Op. 2.0.01.19.0).
- Remove carbon deposit-from combustion chamber (Op. 2.1.03.02.0).

3.1.1.12. THE ENGINE MAKES RHYTHMICAL, ANORMAL NOISES (IT KNOCKS)

The possible causes of these knocks can be:

- Engine running with detonations, which produces greater forces than normally upon piston pin and crhakshaft connecting rod bearings.
- Advanced wear of crankshaft connecting rod bearins.
- Grave troubles of the cluth.
- Slacken of connecting rod bearing covers.

In all these situations an engine general overhauling is absolutely necessary; otherwise can occur extremely grave engine damages.

In case of engine knocks, specific to detonations, perform checkings and remedyings indicated at § 3.1.1.11.

In the second case take engine down from the vehicle (see Op.2.0.10.01.0) and overhaule completely the clutch (Op. 4.1.04.02.0).

3.1.1.13. ENGINE OIL PRESSURE TOO LOW

The trouble is observed on the dashboard oil pressure gauge; besides, the oil pressure alert lights, when engine is running.

The trouble should be immediately found and removed; otherwise it represents a danger of grave engine damaging.

The causes should be sought in the engine oil circuit, excessive bearing clearances, excessive wear of oil pump drive gear, or defective oil circuit tightness, allowing fuel or water inleakages into oil circuit.

Perform checking and remedying in following order:

- Check firstly oil level in the engine sump, if it is not increased, due to fuel or water inleakage (Op. 2.0.01.32.0). If yes, drain completely the oil sump, in order to ascertain the presence of fuel or water in oil (Op. 1.0.01.03.0).
- Check fuel pump for fuel leakage to oil sump (Op. 2.0.01.32.1).
- Check tighteness of cylinder head gasket (2.1.01.32.2).
- Check integrity of cylinder liner ring gaskets (Op. 2.0.01.32.3), and if water leakages will be observed, perform complete overhauling of the engine, concerning waterproofing of cylinder liners. (Op. 4.1.10.02.0).

- Take oil pump down from the engine (Op. 2.0.01.33.0) and check its rate of wear (Op. 4.0.09.01.).
- Perform a complete inspection and checking of clearances between main journals and crank pins, and respective bearings (Op. 3.1.05.04.1). and (Op. 3.1.05.04.2).
- Check also clearances of camshaft bearings (Op. 3.1.02.02.0).

Perform previously all necessary works for respective operations.

3.1.1.14. TOO HIGH OIL CONSUMPTION OF ENGINE

A high oil consumption occurs as a result of damaging of gaskets, causing oil leakages, namely: at rear main crankshaft bearing, at oil sump gasket, oil filter gasket, between pistons and cylinder liners (due to excessive clearances between piston rings and piston ring grooves), excessive clearances between valve stemps and their guides.

It can occur an anormal oil consumption if the used oil is not adequate (as quality and quantity).

To descover the trouble causes and to remedy it, perform the following operations:

- Check oil in the engine sump for its adequate quality and, eventually replace it completely (Op. 2.01.01.28.0).
- Check the spark plugs heads in order to judge combustion quality (Op. 2.1.01.31.).
- Check if there are no leakages of oil at rear main bearing (Op. 2.0.01.35.1) Perform remedying according to respective operation.
- Check if there are no leakages at oil filter gasket, and eventually, change the gasket (Op. 2.0.01.35.3).
- Observe exhausted smoke if it is whitish (without being water vapours in frosty weather). If smoke is whitish it shows that oil burns in the cylinders. If such a phenomenon is oberved (see Op. 2.0.01.34.0). seek the source of oil inleakage into combustion chambers.

- Check compression ratio of cylindres (Op. 2.0.01.36.0) and if this ratio is lower than normal, perform complete checking of clearances between piston rings and piston grooves (Op. 4.1.04.03.0).

  If compression ratio is normal, it means that oil leakages are not caused by piston rings. In this case check clearances between the valves stems and their guides (Op. 3 1.03.03.0), performing then necessary remedyings.

3.1.1.15. TOO HIGH COOLING WATER CONSUMTION OF ENGINE

The cooling water loss can occur by water evaporation, if engine runs too hot or if radiator filler cap is faulty. There can occur also water loss through various joints between cooling system components, through fissured expansion vessel or fissured radiator cells, through damaged cylinder head gasket.

To remedy the trouble, perform following operations:

- Check fan V-belt tension (Op. 2.0.01.10.0).
- Check presence of scale deposits in the cooling system (Op. 2.0.13.02.0) and remove it.
- Check thermostat operation (Op. 2.0.13.05.0).
- Check cooling system tightness (Op. 2.0.13.06.0).
- Check radiator filler cap (Op. 2.0.13.07.0).
- Replace fissured expansion vessel (Op. 2.0.13.06.1).
- If fissured, repair the cooling radiator (Op. 4.0.13.08.0).
- Check cylinder head tightening (Op. 2.0.01.17.0).

3.1.1.16. TOO HIGH FUEL CONSUMTION OF ENGINE

The causes of excessive fuel consumtion are to be found in the engine itself and its afferent systems, as well as in the other mechanisms and units, whose troubles generally introduce a supplimentary output and, implicitly, supplimentary fuel consumtion.

Below will be presented the more important causes and remedyings which can be performed:

- The use of unadequate fuel, concerning its wrong octane number or impurities content. In such a case, drain completely the fuel tank, clean it and fill it with adequate fuel (correct octane number) (Op. 2.0.11.01.0).
- Octane selector is disadjusted, causing too late ignition.
  Adjust octane selector (fixed ignition advance) (Op. 2.0.01.13.0).
- Overrich mixture, causing black smoke in the exaust gases. To remedy the trouble:
- Check air cleaner for clogging (Op. 2.0.08.03.0).
- Check carburettor float chamber for correct fuel level (Op. 2.1.15.02.2).
- Check carburettor main jets if they are not decalibrated.
- Other cause of excessive fuel consumption is the vehicle driving at a speed above the economical one.
- Running of a too cold engine (in winter). In such situation check thermostat operation (Op. 2.0.13.05.0);
- Exhaust system is partially clogged, throttling exhaust of fumes. In such a case:
- Check all exhaust pipes and muffler for clogging (Op. 2.0.12.01.0).
- Check muffler for eventual faults, which obstruct partially circulation of fumes (Op. 2.0.12.02.0).
- Excessive wear of combustion chamber tightening. In this case:
- Check cylinder compression ratio (Op. 210.01.36.0).
  Other cause may be: Vacuum advance control faulty or too little gap of breaker points. To remove the trouble:
- Remedy ignition distributor by replacing its vacuum control unit (Op. 4.0.36.03.1).

CHAPTER IV. REMEDYING OF ARO VEHICLES

4.1. ARO L-25 ENGINE

4.1.1. PRESENTATION OF ENGINE

4.1.1.1. GENERAL DESCRIPTION

The ARO out road (Jeep type) motor vehicles and their variants are equipped with ARO L-25 engines.

The ARO L-25 engine is a four stroke row engine, with 4 cylinders,ignition distributor, fuel pump and carburettor. The iron cast cylinder block has four detachable, wet liners, supported by upper block face and sealed at their lower end with rubber O-rings.

- The cylinder head, common to all four cylinders, has wadged shape combustion chambers.
- The crankshaft, made of special high-strength noduiar cast iron, is supported on 5 shell bearings, while the camshaft is made of the same special cast iron and rests on 3 anti-friction bushes (see fig. 4.1.).
- The crank drive consists of pistons, floating piston pins, forged in an I shape beam piston rods, two compression and one oil scraper piston rings. The piston connecting rods are assembled with half bearings on crank pins.
- The valve gear consists of overhead valves (mounted in cylinder head), actuated by rocker arms.
- The fuel supply system comprises the fuel tank, fuel filter, fuel pump, air cleaner, carburettor and inlet manifold (see fig. 4.2.).
- The engine is lubricated by oil pressure (oil pump & oil filter) and by splashing.
- The engine is cooled by water (or antifreeze cooling fluid) circuilation, with cooling fan, radiator, water pump and temperature controling thermostat.

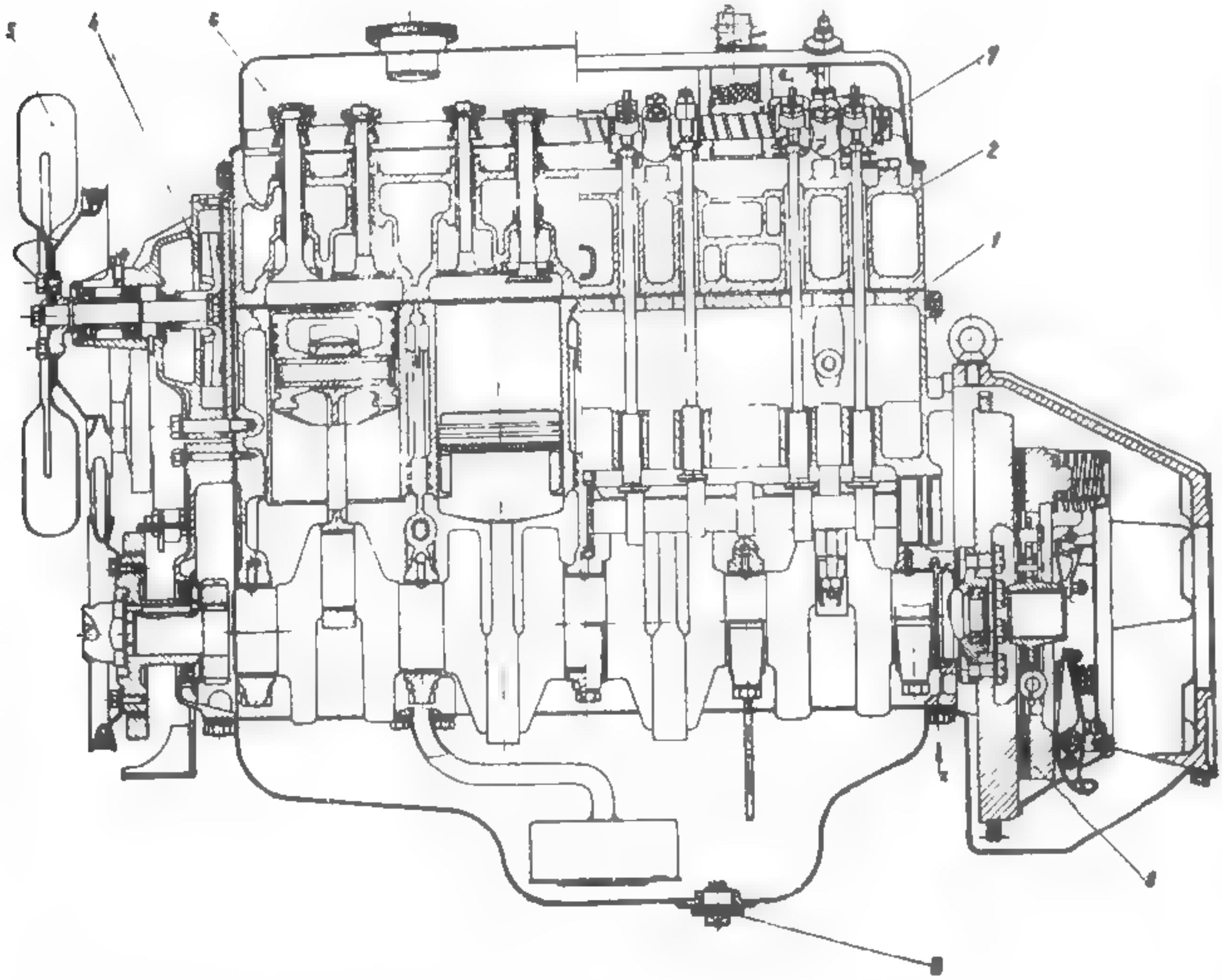


Fig. 4.1.- LONGITUDINAL SECTION OF ARO L-25 ENGINE
1. Cylinder block; 2. Cylinder head; 3. Clutch; 4. Water pump; 5. Cooling fan; 6. Cylinder head cover; 7. Rocker arm shaft; 8. Magnet draining plug.

4.1.1.2. ENGINE MAIN FEATURES

- Type	Four stroke row eninge, with carburettor and spark ignition
- Fuel	Gasoline, having octane number 90.
- Firing order	1 - 2 - 4 - 3
- Number of cylinders	Four, vertical in line
- Bore	97 mm (3.819 in.)

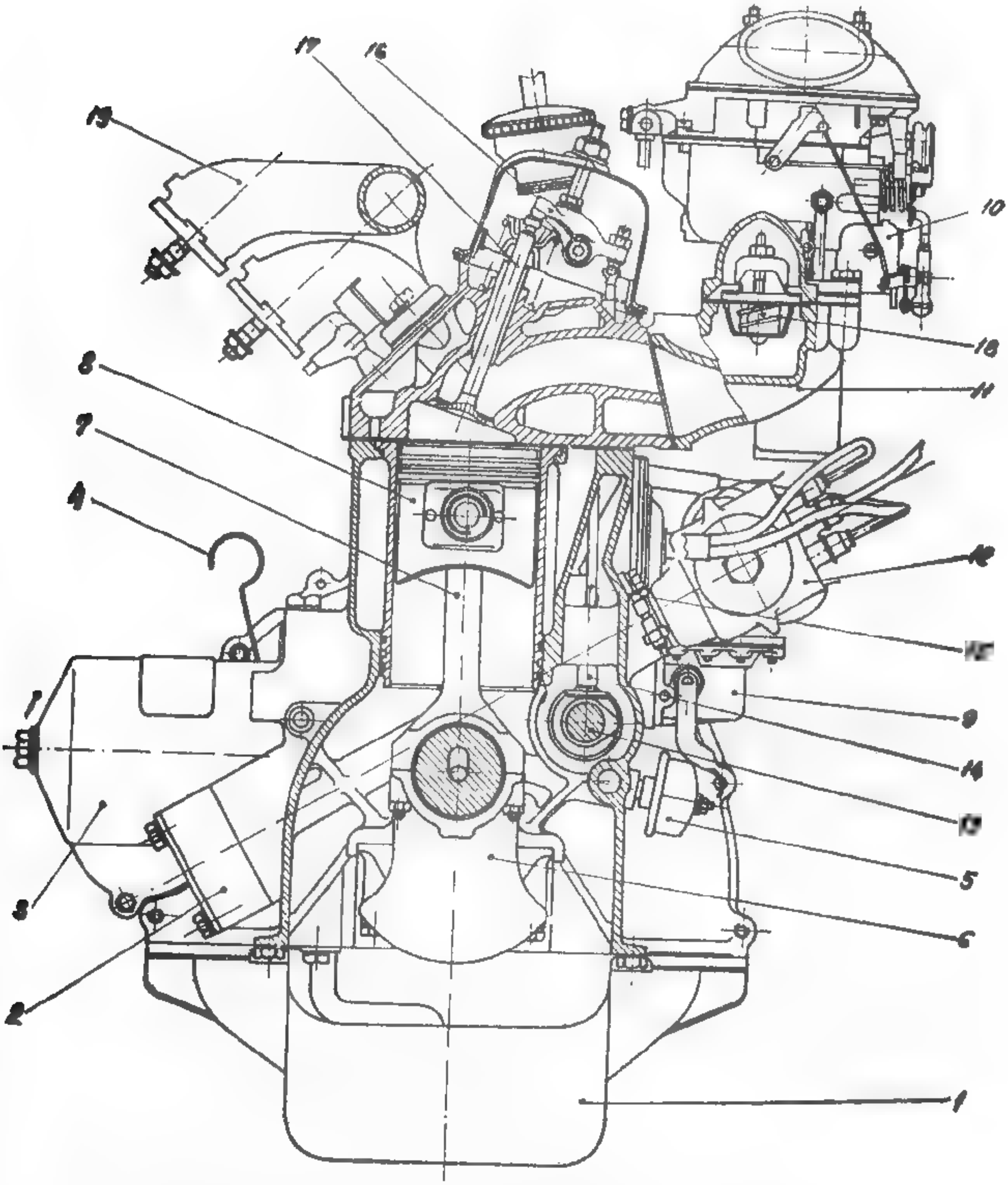


Fig. 4. 2. CROSS SECTION OF ARO L-25 ENGINE.
1. Oil sump; 2. Oil pump; 3. Oil filter; 4. Oil dip stick; 5. Oil pressure manometric sensor; 6. Crankshaft; 7. Piston rod; 8. Piston; 9. Fuel pump; 10. Carburettor; 11. Inlet manifold; 12. Ignition distributor; 13. Camshaft; 14. Tappet; 15. Push rod; 16. Rocker arm; 17. Valve; 18. Thermostat; 19. Exhaust manifold.

Piston stroke	- 84.4 mm (3.323 in.)
- Cylinder capacity	2.495 cm^3 (152 in^3)
- Compression ratio	8 : 1
- Crankshaft sense of rotation	In clockwise direction
- Maximum output	$61\pm5\%$ kW ($83\pm5\%$ H.P.) at 4.000 r.p.m.
- Maximum torque	17.3 daNm (I 12.5 ft.lbs)at 2900 r.p.m.
- Number of copression piston rings	2
- Numner of oil scraper rings	1
- Octane selector (fixed ignition advance)	16^{o} at 1,000 r.p.m.
- Location of valves	O.H.V. in cylinder head
- Inlet valve opens	12^{o} before O.D.C. (outer dead centre)
- Inlet valve closes	57^{o} after I.D.C. (inner dead centre)
- Exhaust valve opens	58^{o} before I.D.C.
- Exhaust valve closes	8^{o} after O.D.C.
- Clearance between valve stem and rocker arm	0.45 mm
- Lubricating system	Mixed (by pressure and splashing)
- Engine cooling	With water or antifreeze fluid.
- Engine suspension	On threee elastic points
- Fuel supply	Mechanical pump with diaphragm
- Oil pump	Gear oil pump
- Oil filter	With paper filtering element
- Air cleaner	Wet, with wire gauze
- Cooling water feed	By means of a water centrifugal pump radiator, thermostat and fan.
- Water temperature control	By means of thermostat
- Carburettor	DCD dual body with differentiated opening
- Nominal voltage	12 V d.c. negative ground
- Ignition distributor	3231 Electroprecizie type
- Advanced ignition control	Centrifugal and vacuum controled

- Breaker points gap	0.35 - 0.45 mm
- Sparking plugs (make/type)	SINTEROM M 14 x 225
- Sparkplug electrodes gap	0.7 mm
- Starting motor (make/type)	UMEB D 1,2 - 12
- Alternator (make/type)	UEPS, 1111 type (12 V d.c. 35 A)
- Voltage regulator (make/type)	UEPS, 1410 type
- Engine idle speed	750 r.p.m.
- Dry engine weight with gear and transfer box	300 kg (660 lbs)
- Valve control	By pushing rods and rocker arms
- Cranc shaft	Casting of nodular cast iron, supported by five main bearings, dynamicaly balanced, being assebled with the flywheel and clutch.
- Engine thermal condition	Cooling fluid temperature: from $80^{\circ}C \pm 2^{\circ}C$ up to $96^{\circ}C \pm 3^{\circ}C$.
- Lubricating system capacity	6 litres, without cooling. radiator; 7 litres, with radiator.
- Oil pressure	Max. 4.9 bars

4.1.2. FUEL PUMP TROUBLES AND THEIR REMEDYINGS

4.1.2.1. FUEL PUMP DISCRIPTION AND MAIN FEATURES

Fuel pump draws gasoline from the fuel tank and delivers it to carburettor. The pump is of the diaphragm type and is actuated by an excentric of the camshaft through the agency of a rocker arm (see fig. 4.3.).

At a camshaft speed of 1250 r.p.m. the pump draws fuel from a depth of 0.750 m and supplies it up to a height of 0.500m, by an output of 60 l/min. At a zero output the oil pressure rises up to 0.177-0.294 bars. The maximal diaphragm frequency is of 2300 osc/min.

At a frequency of 1250 osc/min. the priming of the pump occurs during 7 seconds.

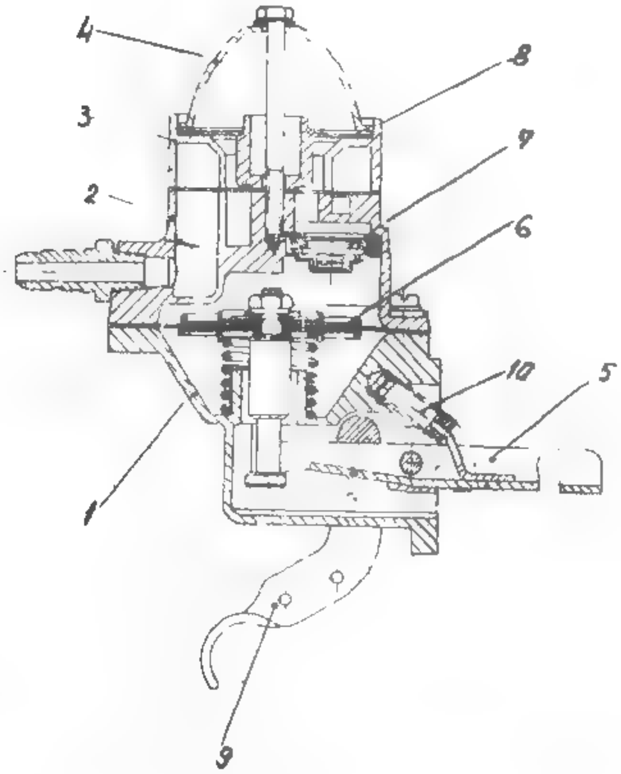


Fig. 4. 3. FUEL PUMP

1. Lower pump body; 2. Middle pump body; 3. Upper filter body; 4. Filter cover; 5. Rocker arm; 6. Diaphragm; 7: Valve; 8. Strainer; 9. Hand level; 10. Backmoving spring; pushing rocker arm upon the camshaft.

The pump consists of three bodies and a cover which fastens all components.

The lower body (1), which fastens the pump on cylinder block, by the agency of two bolts, has a rocker arm (5), actuated by the camshaft excentric, and a hand level (9). The rocker arm shaft is fixed by two tips, pressed on the shaft ends and set in the pump body. The contact between rocker arm and camshaft excentric is provided by the spring (10).

The middle body has the two valves (7), whose fittings are pressed and set in it, and an outlet pipe connection, towards carburettor.

Between the two bodies is fastened the diaphragm (6).

On the tappet (2) - (see fig. 4. 4.) - whose lower end is connected with rocker arm clevis, is fastened the diaphragm (1), between two curved washers (3) and sealing gasket.

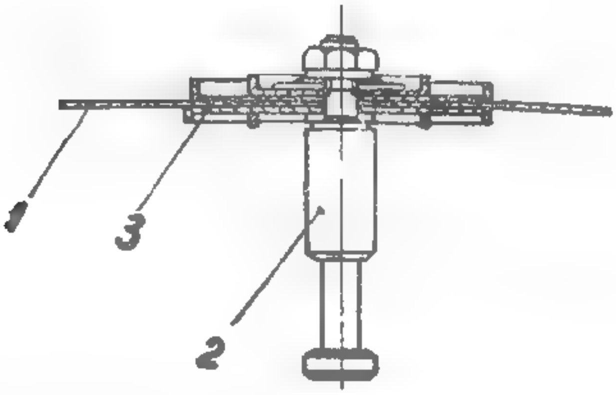


Fig. 4.4. FUEL PUMP DIAPHRAGM ASSY
1. Diaphragm; 2. Diaphragm tappet; 3. Diaphragm washer.

In the lower pump body, under diaphragm, is a spring which always holds diaphragm in pushed position.

The two pump bodies are assembled, having between them the diaphragm as a sealing gasket.

A central bolt fastens the cover (4) and upper body (3) on middle body (2) (fig. 4.3.).

Between upper and middle bodies is a sealing gasket, while between the cover and upper body is fastened a strainer (fine fuel filter).

On the upper body is the inlet pipe connection.

4.1.2.2. FUEL PUMP TROUBLES AND THEIR REMEDYING

The pump troubles can be easier observed when the engine is mounted on vehicle, but they can also be detected separately. Thus:

- The pump does not supply fuel, although there are no fuel leakages in the hand lever area and the fine strainer was ckeaned. The trouble is due to faulty valves, which do not close tightly, or to diaphragm spring, which is deformed or broken. In that case is necessary to replace the valves (OP. 4.1.06.01.1). or the spring (Op. 4.1.06.01.2).
- The pump does not draw the fuel and there are fuel leakages near the rocker arm. In that case the diaphragm is fissured and should be replaced (Op. 2.1.01.26.1).

The pump shows fuel leakages on gaskets and rocker arm, although it is supplying fuel. It means that the gaskets are fissured or the diaphragm has a slight fissure. It is necessary to replace gaskets or diaphragm, according to Op. 4.1.06.01.3.

ATTENTION: On remedying use only original rubber components, fuel resistant.

OP. 2.0.01.26.0 CHECKING FUEL PUMP OPERATION

This operation is performed before taking down the pump from engine.

- Remove carburettor supply tube and actuate manually the pump. If there is a null or insuficient fuel supply, the trouble is caused by clogged fine strainer, which should be cleaned (Op. 2.0.01.12.0).
- If after strainer cleaning the trouble still persists, the cause should be sought in the fuel line pipes, checking them for tightness and free fuel passing (Op. 2.0.11.06.0).
- Now, if the fuel line (the fuel tank filter inclusively) is in good order, the trouble should be inside of the fuel pump, which should be taken down from engine and overhauled.
- Taking down of the fuel pump should be also performed if there are fuel leakages on its gaskets or around near the hand lever. Diagnosing is done according to indications of parapragh 4.1.2.2.

OP. 2.0.01.27.0 TAKING DOWN THE FUEL PUMP FROM ENGINE

ATTENTION ! Take all necessary measures to avoid any fire danger!

- Remove the pipes connecting the pump with fuel tank and carburettor.
- Take down the pump and bring it on a work bench.

On remounting the pump on engine, perform operations in reverse order.

OP. 2.1.01.26.1 REPLACING FUEL PUMP DIAPHRAGM

After taking down the fuel pump, fasten it in bench vice, having protected jaws. Then:

- Unscrew bolts fastening the middle body on lower body (see fig. 4.3.).
- Remove with much care the upper boddy, because the strong tightening of both components, with diaphragm between them, , has caused its rather important adherence. Do not use sharp tools, introduced between the two sealing surfaces!
- Unscrew the nut fastening the curved washer (3) (see fig. 4.4.) on diaphragm (1). Pay much attention on unscrewing the nut, because the spring pushes the whole assembly out from the tappet (2).
- Replace faulty diaphragm with the new, original one.
- If there are leakages near the hand lever, but the diaphragm has no fissures, replace sealing gasket which is under the diaphragm, set on the lower curved washer.
- On refitting the pump, perform operations in reverse order.

OP. 2.0.01.32.1 CHECKING FUEL PUMP FOR FUEL INLEAKAGES INTO OIL SUMP

- Actuate manually the fuel pump and check if some leakages occur near the hand lever. If this situation is doubled by oil level increasing in the engine sump, concomitantly with oil thining, it means that the pump diaphragm is fissured. For trouble remeding:
- Take down the pump from engine (Op. 2.0.01.27.0) and replace diaphragm or sealing gasket, between diaphragm and lower curved washer, on the tappet (Op. 2.1.01.26.1).

ATTENTION! On all intervention concerning the fuel supply system take special measures to avoid fire danger!

OP. 4.1.06.01.0 COMPLETE OVERHAULING OF THE FUEL PUMP AND REPLACING ITS WORN OUT COMPONENTS

This overhauling is carried out on work bench, after taking down the fuel pump from engine (Op. 2.0.01.27.0).

A fuel pump in good order should supply 60 l/min. $\pm$ 10%, when its rocker arm is actuated with a frequency of 1250 osc/min, drawing gasoline from a depth of 0.750 m and supplying it up to height of 0.500 m, in atmosphere standard conditions (760 Hg mm pressure and 20^{o}C temperature). If these conditions are different, respective corrections should be done.

If these standard performances are not realized, it means that there are worn out components in the pump: decalibrated spring, faulty valves, which do not close - and should be replaced.

- For spring replacing, see Op. 4.1.06.01.2.
- For valves replacing, see Op. 4.1.06.01.1

Peform refitting of the pump in reverse order.

Pay special attention for fire danger!

OP. 4.1.06.01.2. REPLACING DIAPHRAGM CONTROL SPRING

- Take down fuel pump from engine block (see Op. 2.0.01.27.0).
- Unscrew cover bolt and remove the pump cover (4) - see Fig. 4.3. - fine filter strainer (8), sealing gasket, upper pump body (3) and gasket sealing upper body.
- Unscrew bolts fastening middle body and remove middle body, paying attention to not damage the diaphragm.
- Detach carefully diaphragm all around, from lower body.
- Remove the rocker arm control spring and shift the rocker arm pin, in order to get control tappet free.
- Remove diaphragm assembly, together with control tappet, making diaphragm pushing spring free.
- Now, check this spring, which compressed up to a lenght of 21 mm should have a force of 5.5. $\pm$ 0.6 daN (13 lbs.). Do not forget that this main spring provides correct performances of the pump. As always, on any intervention in the fuel supply system, pay special attention for fire danger preveniting!

OP. 4.1.06.01.1 REPLACING THE PUMP VALVES

- Take all necessary measures against fire danger!
- Take down the fuel pump from engine (see Op. 2.0101.27.0).
- Unscrew the bolt of the pump cover and remove cover, fine strainer, cover sealing gasket, upper pump body and its gasket.
- Unscrew bolts fastening middle body on the lower body and remove carefully the middle body, in order to not damage the diaphragm.
- Remove both valves (which are pressed in the middle body) and replace them with new, original valves.
- Refit the pump in reverse order.
- Pay attention for fire danger!

OP. 4.1.06.01.3 REPLACING PUMP SEALING GASKETS

- Take down the fuel pump from engine (Op. 2.0.01.27.0).
- Unscrew bolt fastening the cover and remove the cover, to make accessible its gasket.
- Remove middle pump body, to make accessible its gasket. For this, unscrew bolts fastening it on lower body.
- Remove from lower body the gasket, if it has adhered to body, due to prolonged pressing.
- Remove spring (10) (see fig. 433.), which actuate the rocker arm.
- Remove, by shifting, the rocker arm pin, and remove rocker arm, making free diaphragm-tappet assemply; pay attention for this operation because the the diaphragm is always pushed by the spring, located under it.
- Remove diaphragm and dismantle it from tappet, making accessible the sealing gasket on the tappet.

ATTENTION! The gasket should be replaced only with original components, fuel resistant.

Refit the fuel pump in reverse order.

As always, pay special attention for preventing any fie danger!

- Finaly check if the new gaskets provide the tightness of the pump.

4.1.3. CARBURETTORS TROUBLES AND REMEDY

4.1.3.1. DESCRIPTION OF CARBURETTOR AND MAIN CHARACTERISTICS

The 36/42 DCD carburettor is of vertical type with downdraft, having two mixture chambers with double venturies (one primary step and one secondary step) and a constant level chamber balance with the zone from the air filter oval.

Each mixing chamber is provided with an obturating valve placed each on a valve port axle. The control of the obturating valve opening and closing is made mechanicaly, differentiately.

The 36/42 DCD carburettor is provided with:

- acceleration pump with piston, actuated by a lever solidary with one of the obturating valve port axles;
- stud for the control depression of the vacuumatic advance;
- choke with air valve mechanicaly controled by means of flexible cable from the motor vehicle's cabin;
- the compensation of the fuel mixture is performed by progressive drawing out from the depression of the main nozzle (air braking);
- qualitative the mixture for slow idle running is adjustable for each mixture chamber by of the adjusting srews of both steps;
- quantitative the fuel mixture is adjusted by the opening of the obturating valve of the primary step.

The 36/42 DCD carburettor comprises calibrated mechanisms

(1 unit = 1 miccron) Thus	First step	Second step
0	1	2
- little ventury	9	
- little ventury discharge hole	5	
- big ventury (ventury cone)	28	28
- main nozzle (marked calibration)	120	125
- air brake main nozzle (marked calibration)	260	260
- emulsion tube (marked)	F3	F3

0	1	
Idling gear and progressive		
- fuel nozzle for idle running (marked calibration)	52	75
- air nozzle for idle running (marked calibration)	160	70
Acceleration mechanism		
- accelerator pump piston stroke		12 ± 0,5
- accelerator pump charging valve		closed
- accelerator pump discharging nozzle (marked)	60	
Constant level mechanism		
- fuel inlet valve (obturator with needle)		200
Other calibrated parts		
- load nozzle	50	50
- transfer holes	90	90

4.1.3.2. OPERATION OF THE CARBURETTOR'S MECHANISMS

Faulty carburettor operation is found by faulty carburation, respectively by back fires, exhaust of unburnt gases (with much smoke), high fuel consumption, resulting usualy from disadjusting of one carburettor mechanisms.

4.1.3.2.1. NORMAL RUNNING MECHANISM OPERATION

The fuel from the constant level chamber, passes through the two main nozzles 1 (see.fig. 4.5) arrives into emulsion tubes 2, where it mixes the air that passes through the main air braking nozzles (3).

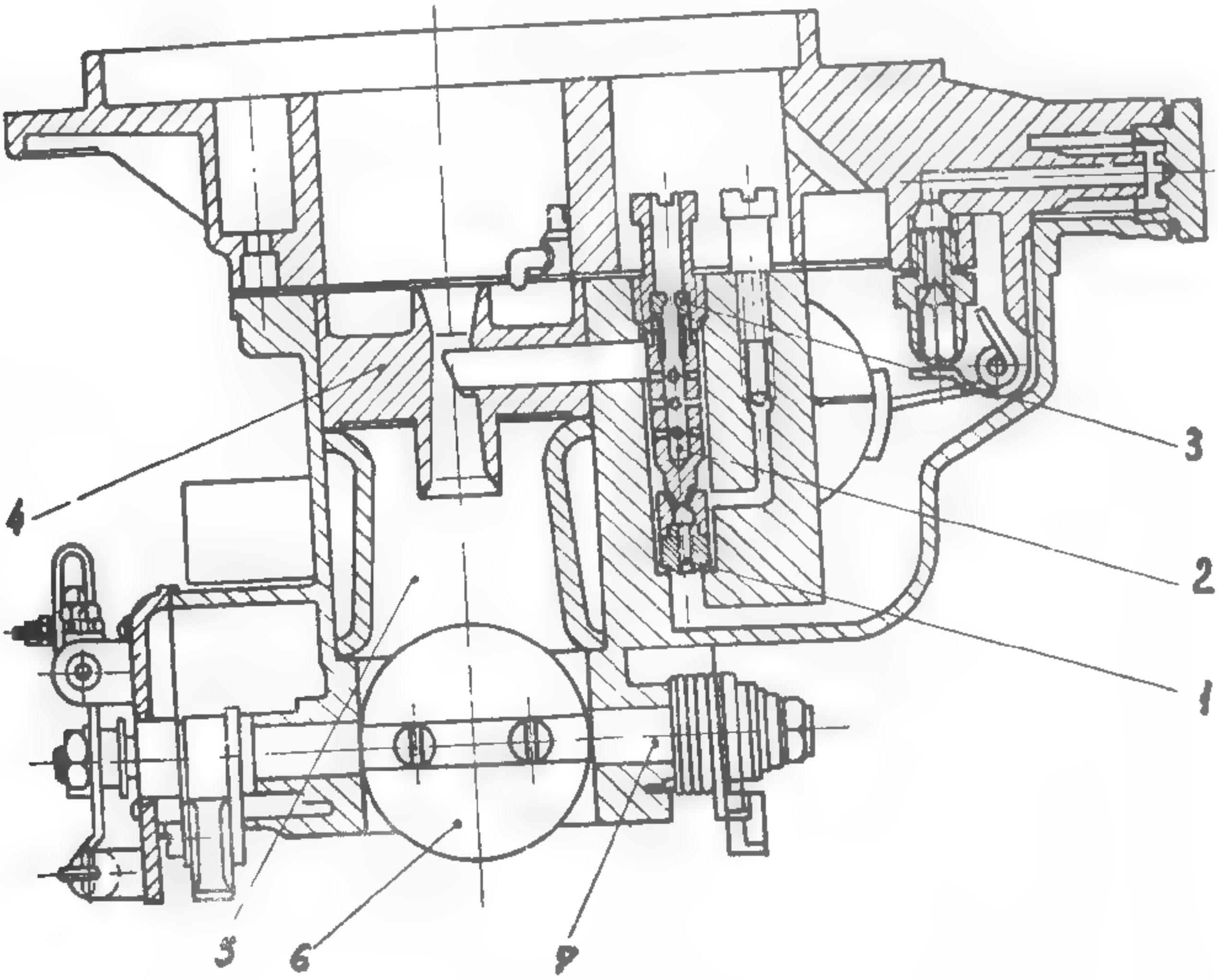


Fig. 4.5. CROSS SECTION OF CARBURETTOR.
NORMAL OPERATION SYSTEM.
1. Main jet; 2. Emulsion tube; 3. Jet correction air bleed;
4, Mixture centring guide; 5. Venturies; 6. Throttle butterfly;
7. Butterfly shaft.

Combustible mixture is absorbed through the mixture centring guide 4, and from here, finely atomized, is mixes with the fresh air into the ventries 5.

The combustible mixture consumption, respectively the engine autput is controled by the agency of the accelerator valves 6, actuated by rotating of shaft 7 from the accelerator control system.

Position of valves and their differentiated motion, is so that the valve of step I opens first and than the valve of the second step is assured by sector 2 and lever 3, see fig. 4.6.

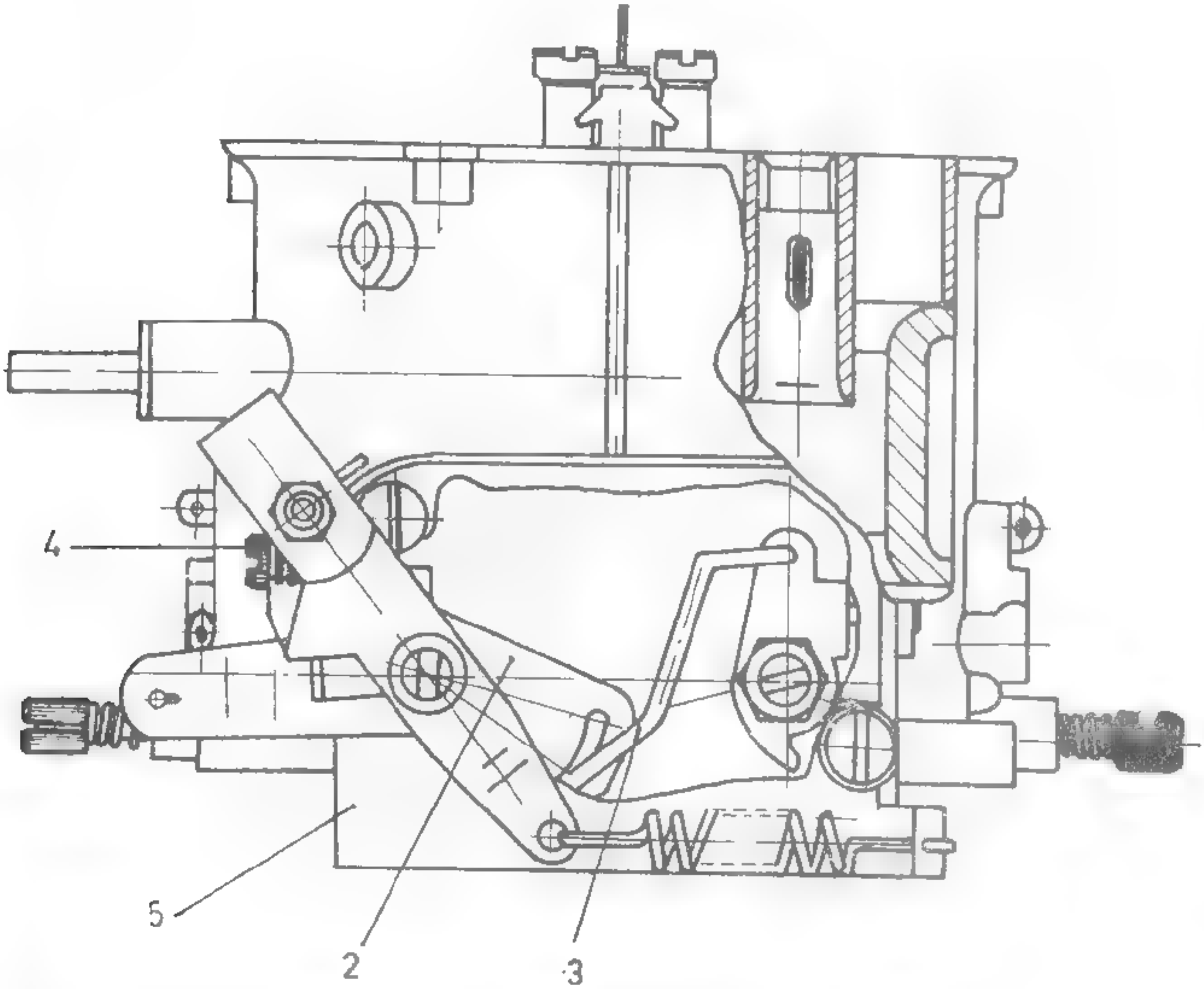


Fig. 4. 6. MECHANISM OF SINCRONIZED MOTION OF THROTTLE BUTTERFLIES.

For high loads the fuel mixture is enriched by opening of the load valve (2) actuating the acceleration pump piston when the acceleration pedal is actuated at maximum stroke see. fig. 4. 7.

In that moment the piston actuates the load valve opening access of the suplimentary gasoline that passes through the enriching nozzle 3 towards the mixture venturies.

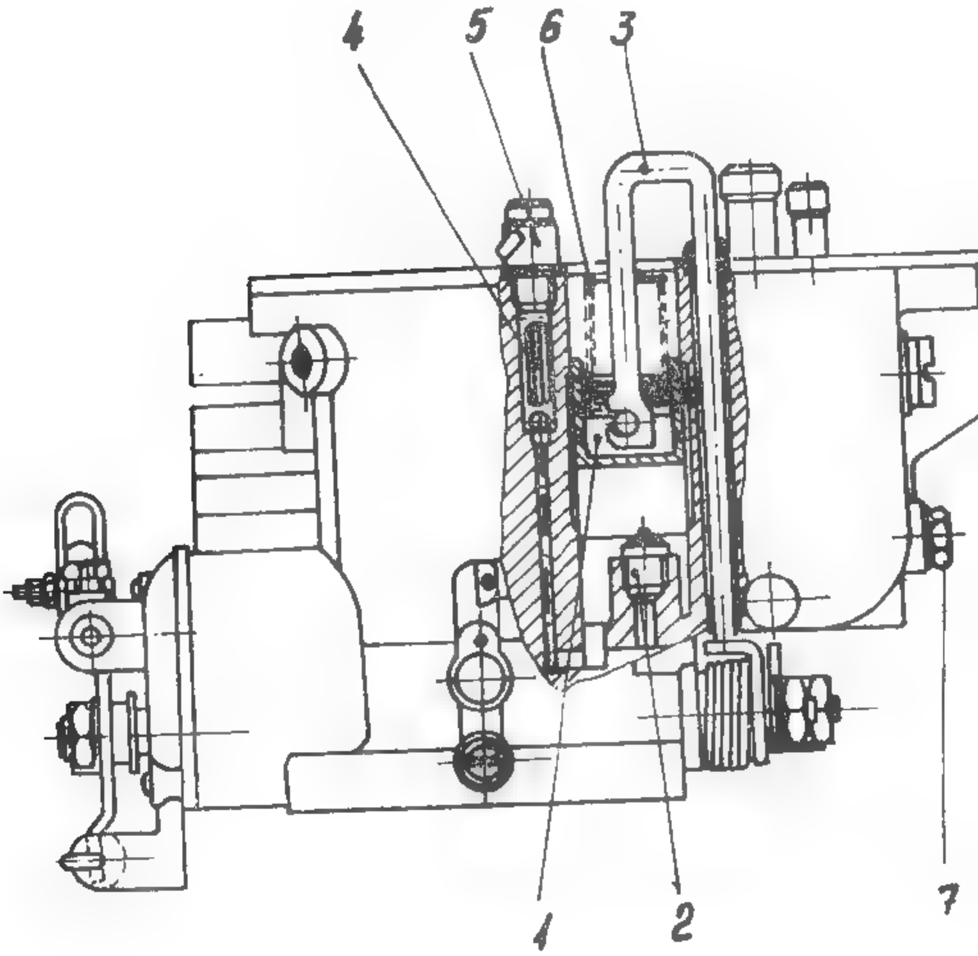


Fig. 4.7. INLET (CHARGE) VALVE
1. Accelerator pump piston; 2. Inlet (charge) valve; 3. Acceleration piston control rod; 4. One-way valve; 5. Accelerator distribuitor for supplementary fuel on acceleration or full load; 6. Accelerator piston spring.

4.1.3.2.2. OPERATING OF THE CONSTANT LEVEL CHAMBER

In the superior carburettor body see fig. 4.8 there is the mechanism for flow adjusting, so that the level in the chamber remains constant.

On the passing channel from the inlet pipe connexion towards the carburettor's chamber, the obturator with needle is mounted (marked 200) being screwed in and tightened by a gasket.

A swingable support wears the 2 floaters and by the front and rear levers actuates the needle in to the obturator with needle and limits the opening

stroke so that between the caps inferior part and floater's surface existes space of 7.5 - 8 mm above the full closed position and 13 - 13,5 for the full open position.

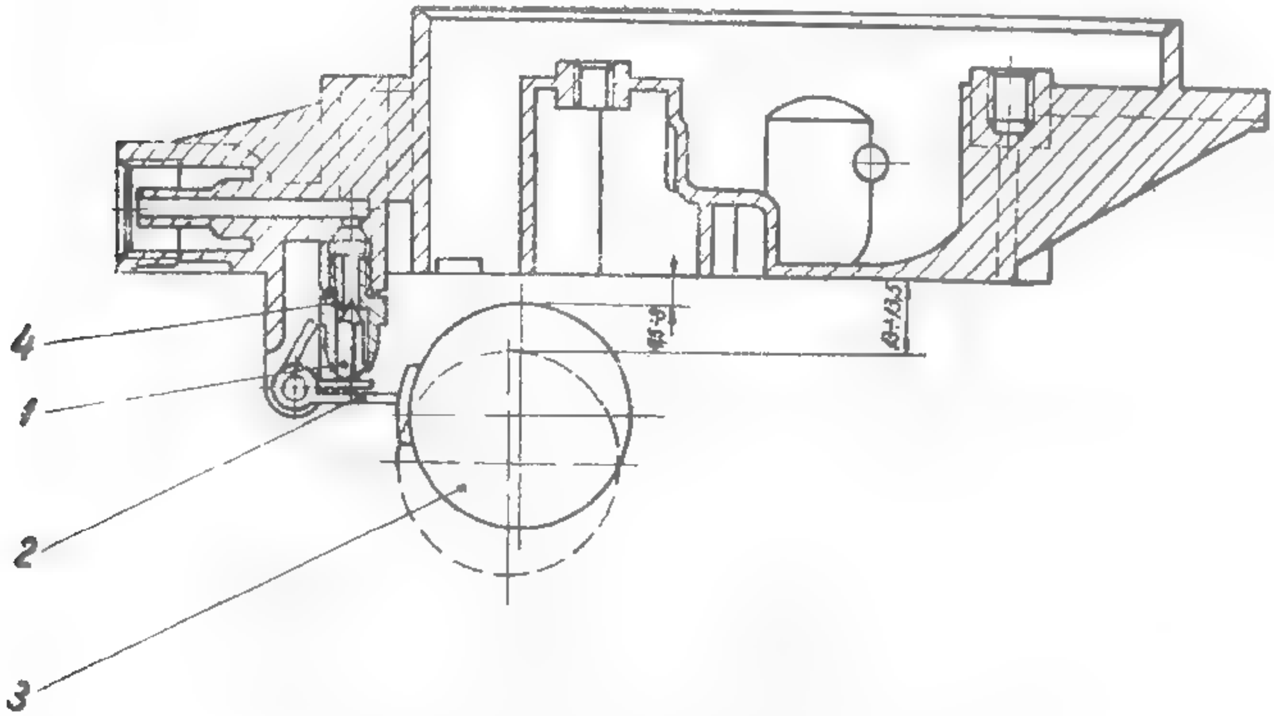


Fig. 4.8. CARBURETTOR UPPER BODY WITH FUEL CONSTANT LEVEL MAINTAINING MECHANISM
1. Needle valve; 2. Actuating lever; 3. Float assy; 4. Neddle valve body.

The swinging assy with the 2 floaters has a weight of 12.5 gr.

4.1.3.2.3. OPERATION BY SLOW AND PROGRESSIV RUNNING

The fuel from the constant level chamber (1) see. fig. 4.9, passes through the main nozzles 9 to the idle nozzles 10.

The butterfly throttles (2) being almost closed no sufficient depressure is formed in the mixture centerings, so that combustible mixture can be formed in the emulsion tubes (3). which could be drawn into the mixture chamber (ventury).

The fuel comes into the emulsion channel 4 where it is mixed with the air that comes through the air nozzle (8).

The formed combustible mixture passes through the channels to the idle supply holes (5) and mixes with the air which passes al a great speed close to throttle butterfleis (2).

The adjusting screws (6) doses combustible mixture amount, so that engine runs at a minimum speed.

To accelerate the engine it is necessary a greater amount of combustible mixture it is obtained by progressive opening of throttle butterflies.

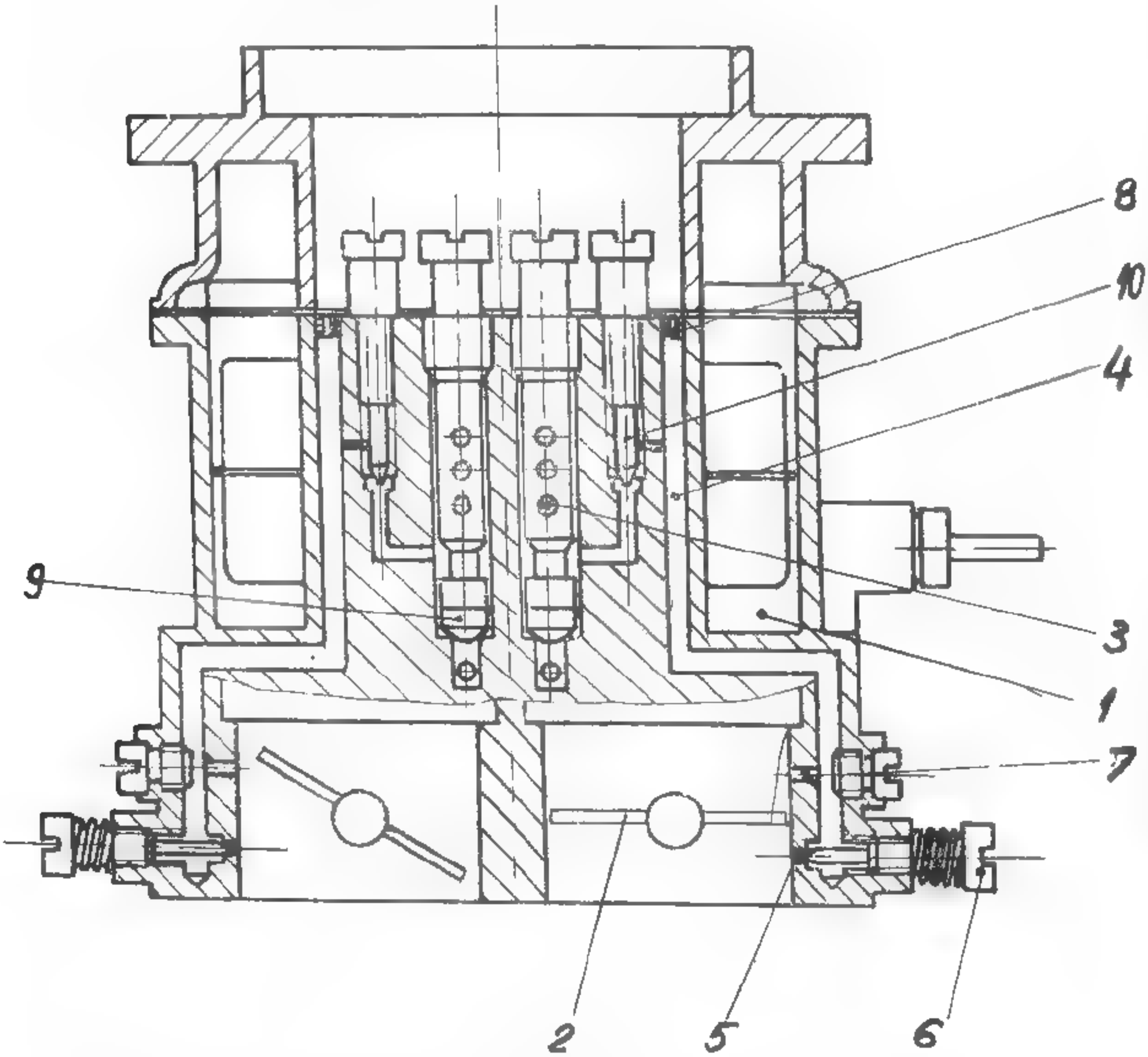


Fig. 4.9. IDLING OPERATION MECHANISM
1. Float chamber; 2. Throttle butterflies; 3. Emulsion tubes; 4. External emulsion tube; 5. Idle speed supply hole; 6. Idle operation adjusting screws; 7. Holes for acceleration starting (progressive operation); 8, Idle running air bleed. 9. Main nozzles: 10. Idle Nozzles.

The local depression which arives between the butterfly I. st. step and wall causes the drawing of combustible mixture suplimentary amount through calibraed transfer holes 7.

The drawing of suplimentary mixture in creases as the butterfly I. st. step opens more up to a limit when the depression between the butterfly step 1 and carburettor's wall descreases, but in this time a sufficient depression is reached in mixture centering guide, so that the main nozzles being to operate.

4.1.3.2.4. OPERATION ON ACCELERATING

When the accelerator pedal is pressed down, together with the butterflies (1) opening (see.fig.4.10) the accelerator pump control lever gets free (2) and accelerator piston (3) is pushed by the spring (4) pusting fuel through connecting channel (5) to the mixture chamber

On passing the fuel pushes the ball valve (6) and arrives through accelerator fuel distributor (7) above the mixture chamber of step 1 (8).

The ball valve is maintained in its shul position by the natural weight of the valve weight (9).

When the foot is taken from the acgelerator pedal and the butterflies get free to shut (an external spring actuates upon the actuating lever of the accelerator butterflies the actuating rod (2) is rised and together with it the piston. The depression that is formed under the piston closes the ball valve (6) and opens the fuel aspirating valve, from the constant level chamber filling again the cylinder (11) in view of a new acceleration.

4.1.3.2.5. OPERATION ON ENGINE STARTING (WITH THE PULLED CHOKE

The engine starting needs for a short time a very rich combustible mixture.

Pulling the choke, the control lever (1) see. fig. 4.11 rotates the choke valve 2 closing the air access to mixture chamber.

By means of a linkage, a half-opened position of the throtlle butterfly of step I (3) is assured.

The starting motor is started by rotating crankshaft of the engine.

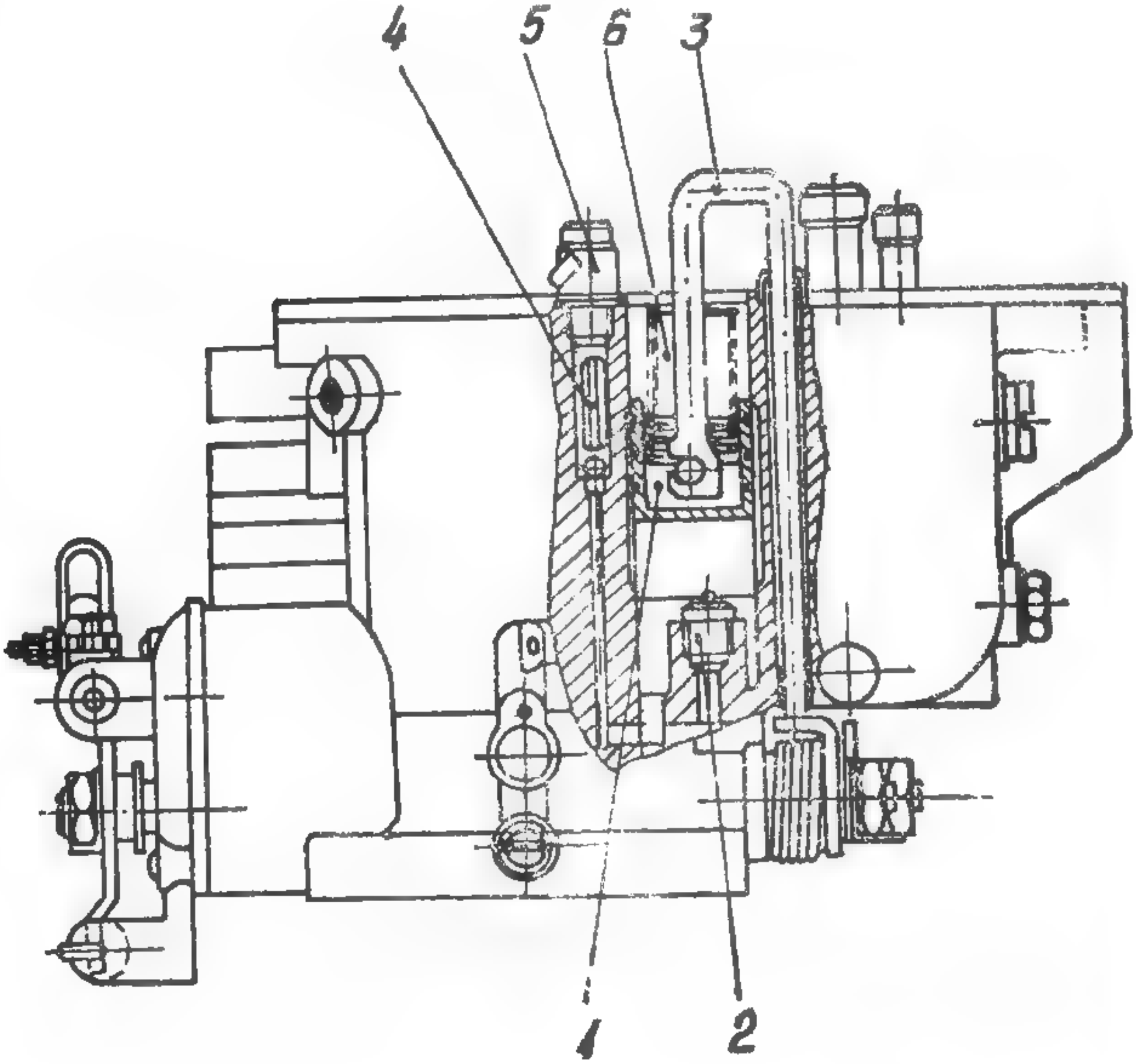


Fig. 4.10. CARBURETTOR ACCELERATION MECHANISM
1. Accelerator pump control lever; 2. Pump piston control rod; 3. Accelerator pump piston; 4. Accelerator piston spring; 5. Connection part; 6. Valve ball; 7. Accelerator fuel distributor; 8. Mixture chamber; 9. Valve weight; 10. Discharge valve; 11. Accelerator pump cylinder.

The arising depression draws through the part of mixture centring guides of step I (4) a very rich, combustible mixture which facilitates engine starting.

Once the engine started the formes depression is greater and opens the air valve (6) allowing a greater air jet which reduces the inriching of the

mixture sprayed from the mixture centering guid tubes (4) allowing a regular engine operation.

During engine heating the choke valve (2) must be opened progressively.

4.1.3.3. CARBURETTOR TROUBLES AND THEIR REMEDYINGS

Except the troubles, which are to be remedyed on normal carburettor maintenance and which do not require its taking down from the vehicle, there are some faults which do not require its taking down.

Carburettor troubles have as immediately observable effect incorrect engine running.

The lack of fuel on engine can result from carburettor, whose needle valve seat is clogged with impurities, which have passed through inlet fine filter. It can also result from incorrect fuel level in the float chamber, due to worn needle valve, which jammed in its seat.

For remedying these troubles perform succesively: needle valve seat cleaning (Op. 2. 1. 15. 02. 1), correct float assy, position checking (Op. 2. 1 15. 01. 2) and needle velve wear checking (Op. 2. 1. 15. 01. 3).

- Too great fuel supply, which floods the engine, can result from needle valve which does not close tightly on its seat, causing a too high fuel level. It can also result from decalibrated main jets.

For remedying of these troubles perform the checking of needle valve (Op. 2. 1. 15. 01. 3), checking of fuel level in float chamber (Op. 2. 1. 15. 01. 2) and checking the main jets for decalibration (Op. 2. 1. 15. 06. 0).

- The engine does not accelerate, because carburettor accelerator piston is worn out, the valves of accelerator circuit are faulty (do not close tightly), the accelerator piston spring is decalibrated or broken, or the ports of accelerator circuit are clogged.

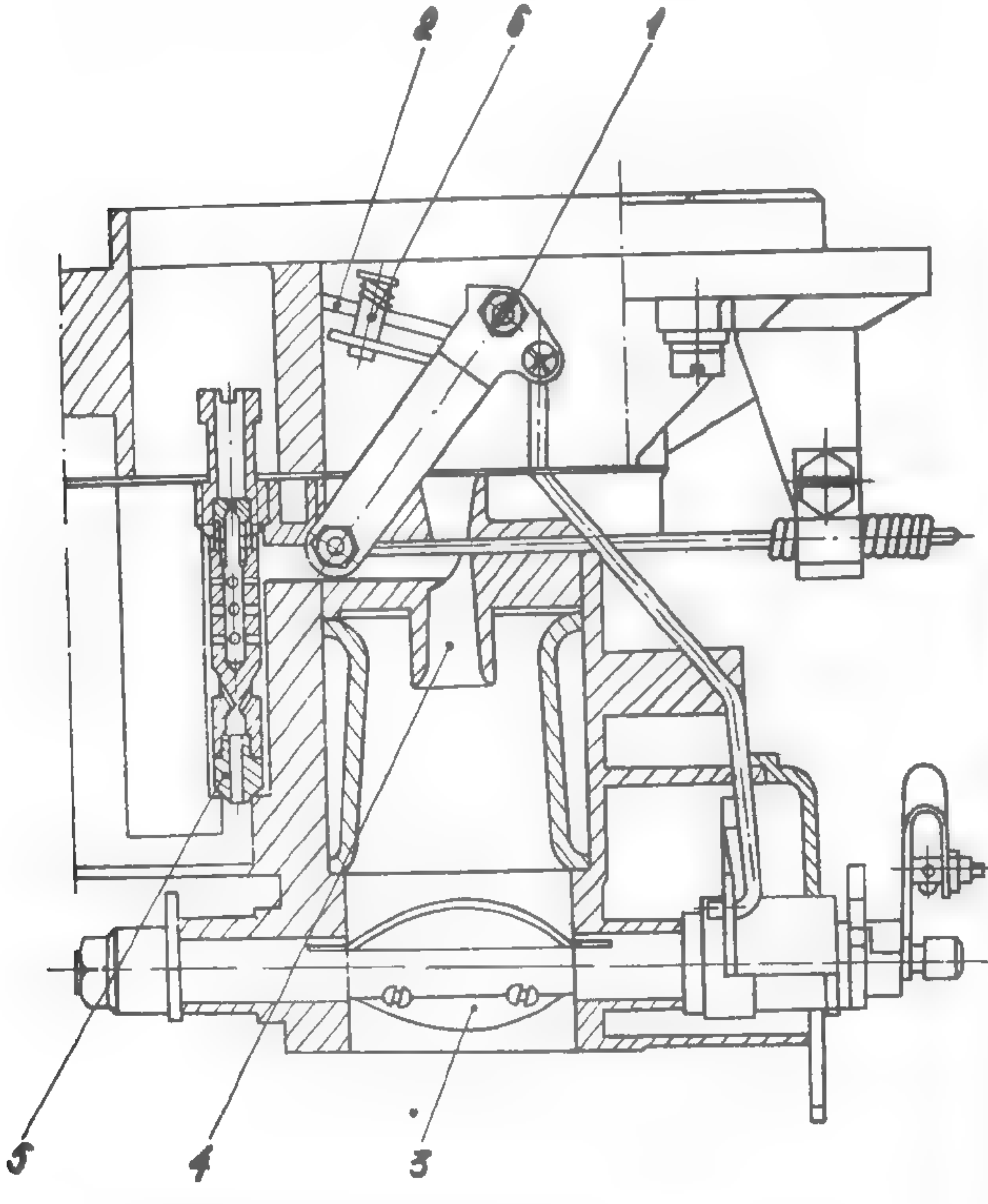


Fig. 4.11. ENGINE STARTING MECHANISM

1. Control 'evel; 2. Choke valve; 3. Throttle butterfly; 4. Mixture centring guide; 5. Main jet; 6. Choke valve.

The trouble remedying needs taking down from engine of lower carburettor body (Op. 2.1.15.02.0) and checking, respectively repair of accelerator mechanism (Op. 4.1.15.07.0).

- The idle engine running cannot be correctly adjusted, due to clogged or de-calibrated idle jets.

  Perform cleaning of idle jets and idle running holes (Op. 2.15.03.0), after having previously taken carburretor down from engine (Op. 2.1.15.02.0).

  The choke actuating is insufficient or, on the contrary, floods quickly the engine. For remedying, check correct choke operation (O . 2.1.15.04.0).

- The engine running is irregular, due to unequal fuel supply of cylinders. This trouble can result from faulty throttle butterflies mechanism, which should be checked as in Op. 2.1.15.05.0.

OP. 2.1.15.01.0 TAKING CARBURETTOR UPPER BODY FROM ENGINE

- Disconnect carburettor from air cleaner, by dismantling the adapter (Op 2.01.01.16.1).

ATTENTION! Take all necessary measures to avoid any fire danger!

- Disconnect carburettor from the fuel pump.
- Dismantle carburettor upper cover by unscrewing the 6 upper bolts (four in-side and 2 outside, near inlet pipe connection).

  Take care to not damage the gasket between the two carburettor bodies, what can cause air inleakages.

  As long as the carburettor will remain with its upper body dismantled it should be covered with a plate, as tightly as possible, in order to hinder any penetrating of impurities in carburettor, and further, into engine itself, which can endanger gravely the engine:

- Perform carburettor refitting in reverse order.

OP. 2.1.15.02.0 TAKING DOWN MIXING CHAMBERS BODY FROM ENGINE

- Take carburettor upper body down, as described in Op. 2.1.15.01 0.
- Take carburettor lower body (mixing chambers body) down from inlet manifold, making free concomitantly insulating and the two sealing gaskets
- Protect inlet manifold with a cover, to avoid impurities penetrating.

  On refitting take special care for correct setting of components, in order to avoid any air inleakages.
- Refit carburetor in reverse order.

OP. 2.1.15.01.1 CLEANING CARBURETTOR NEEDLE VALVE AND ITS SEAT

- Dismantle upper carburettor body, according to Op. 2.1.15.01.0
- Put the upper carburettor body on a work bench, with the floats upwards and remove float spindle.
- Remove carefully the floats assembly taking care to not deform its levers.
- Remove needle valve, which is now free.
- Unscrew the needle valve seat, together with its gasket and clean the seat by air blasting. On occasion, use for cleaning a wooden chip.
- After cleaning refit all in reverse order.

OP. 2.1.15.01.2 CHECKING CARBURETTOR FLOAT CHAMBER FOR RIGHT LEVEL

- Dismantle upper carburettor body, as described in Op. 2.1.15.01.0.
- Check distance between float top and upper body underside (without gasket), which should be of 7.5 - 8 mm for float upper position, and of 13 - 13.5 mm for its lower position. If these distances are wrong, correct them by bending of the front and rear levers of the float assembly, which actuate the needle valve and limit its stroke, untill correct distances will be obtained (above mentionned)

- If bothe mentionned distances are correct, but the carburettor is altough flooded, it means the the float weight is wrong. In this case remove the float assembly spindle and weigh the float assembly. The float weight should be of 21.5 g (0.44 ozs).
- In case that the float assembly got heavier, due to fuel inleakage, heat moderately the assembly up to 60 - 70 ^{o}C (140-158 ^{o}F), untill the fuel evaporates.
- Check the fissure through which the fuel penetrated into respective float, by introducing the cold float assembly in warm water: the air from inside will expand and will come out in shape on fine bubbles, marking so the fissure.
- Close the fissure by tinning, without exceeding the tin weight of 0.1 g (0.056 drams).
- If the floats bodies are deformed, there is nothing doing and they should be replaced with original float assembly.
- Refit all in reverse order.

OP. 2.1.15.01.3 CHECKING NEEDLE VALVE WEAR

- Dismantle carburettor upper body, as described in Op. 2.1.15.07.0.
- Put it on a work bench, with the floats upwards and remove the float assembly spindle.
- Remove carefully the float assembly, without deforming its front and rear levers.
- Remove needle valve, which is now free.
- Unscrew needle valve seat and remove it with its gasket.
- Check if needle valve closes tightly, by the agency of compressed air and water and soap.
- If the needle valve does not close tightly, replace it. For lack of a new needle valve, grind the point of the worn needle valve under an angle of 60 ^{o} and repeat tightness cheking, If the result is still negative, replace the needle valve seat.

OP. 2.1.15.03.0 CHECKING AND CLEANING IDLE JETS

- Disconnect carburettor from air cleaner, by taking down carburettor adapter, according to Op. 2.0.01.15.1.
- Unscrew idle running jets and blast them with compressed air; if it will be stricity necessary, you can use for disclogging wooden needles, but so that wooden chips do not remain in the jet hole.
- Unscrew partially the idle running adjusting screws and clean by air blasting the ports of idle running system.
- Check also the holes which are in the throttle butterflies chambers. If the outlet holes are clogged, unscrew completely the idle adjusting screws and the sealing plugs, above them - which provide access to the progressive running holes - and clean them by air blasting or with wooden chips.
- Refit all in reverse order.
- Adjust now idle engine running, as indicated in Op. 1.0.01.22.0.

OP. 2.1.15.04.0 CHECKING CHOKE CORRECT OPERATION

- Disconnect carburettor from air cleaner, by dismantling its adapter, according to Op. 2.0.01.15.1.
- Check if choke valve is normally opened and if, on a slight depressing of its spring tappet, it opens more (see fig.4.11, tappet (6)).
- Check if on rotating the choke shaft (1) the valve oscilate correctly, closing its inlet, in its position "Choke pulled".
- If the shaft is curved and its rotating occurs withjammings, or does not close the chamber, it should be completely dismantled. For this:
- Unscrew the two screws which fasten the choke valve on its shaft and remove the valve.
- Remove choke shaft control lever and pull out the shaft in order to straighten it or replace it with a new original shaft.
- Refit all in reverse order.

2.1.15.03.0. VERIFYING OF BUTERFLY THROTTLE MECHANISM

Unmount of inferior carburettor body according to operation 2.1 15.02.0.

Notice by the inferior part if the butterflies have a differentiated motion, open first the step I. and then the II-nd step.

If you notice the butterflies clearance on the axle tighten the fixing screws.

In case of a to big displacement or a to big wear out unmount the protecting cap (5) fig, 4.6 of sector (2) and of lever (3) so that you can replace the damaged parts by original parts.

Mountii is done in contrary order of unmounting.

Verifyng of carburettor flange flatness

- Unmount the carburettor from the inlet manifold;
- turn it with the inelt manifold laying flange up wards;
- verify the flange flatness by means of a metal ruler.

When a distorsion on the carburettor flange is noticed rework the flange's surface.

OP. 2.1.15.06.0 CHECKING MAIN JETS FOR DECALIBRATION

- Take down carburretior adapter to air cleaner, according to Op. 2.0.01.15.1 Remove the two main jets.
- Check jet orifice diameter, by the agency of a calibrated wire, corresponding to the marked value on jet. Faulty jets should be replaced with original ones.
- Refit carburettor in reverse order.
- After that, adjust again carburetor for idle engine running. (Op. 1.0.01.22.0).

OP. 4.1.15.07.0 CHECKING AND REMEDYING ACCELERATOR MECHANISM

The engine does not accelerate. This trouble can result from: leakiness of discharge valve (10) - see fig. 4.7), causing fuel back leakage from accelerator cylinder; accelerator piston wear, causing fuel back leakage between piston and cylinder wall; decalibrated or broken accelerator piston

spring, which normally should push the piston on accelerating, supplying more fuel.

To remedy trouble:

- Take down upper carburettor body, according to Op. 2.1.15.01.0.
- Remove discharge valve (10) and check it for tightness, by the agency of compressed air and water with soap.
- Remove accelerator piston, by extracting its control rod (3) and check its rate of wear, by measuring. It is not allowed a clearance between the piston and cylinder more that 30 microns (0.030 mm).
- Dismantle accelerator distributor (5), from upper side of carburettor body, and clean it, if clogged, by air blasting.
- Check if accelerator piston spring (6) is decalibrated or broken.
- Remove ball valve (6) and its weight (9) (see fig. 4.10) - by overturning the carburettor body, paying attention for ball valve, and clean port of accelerator circuit by air blasting.
- Replace faulty parts with new, original ones.
- Refitt all in reverse order.

OP. 2.1.15.08.0 CHECKING OVERLOAD MECHANISM

- Take down carburettor upper body, according to Op. 2.1.15.01.0.
- Remove acc. distributor (7) - see fig. 4.10 - and check it for tightness, by agency of compressed air and water with soap.
- Remove accelerator piston, after extracting its control rod (2).
- Remove discharge valve (6) and check it for tightness, by the agency of compressed air and water with soap.
- Refit all in reverse order.

4.1.4. TROUBLES AND REMEDYINGS OF LUBRICATING SYSTEM

4.1.4.1. LUBRICATING SYSTEM DESCRIPTION

The lubricating system of ARO L-25 engine is of mixed type, i.e. pres-

connecting rod big end bearings. camshaft bearing bushes, rocker arm shaft bearing and oil pump-ignition distributor driving shaft are pressure lubricated. All other moving parts (timing gear, distributor driving gear, the contact between tappets and cams) are lubricated by splash or drip (see fig. 4.12).

The oil pump (2) draws oil from oil sump through strainer (1) and delivers it through oil piping in the oil filter (3). On the pipe connecting the pump with the fine filter is a pressure control valve, protecting the pump.

From the fine filter oil passes through oil central manifold.

From here, oil passes under pressure to crankshaft journals and then, throug the parts in crankshaft, to crank pins bearings.

On the the other hand, oil passes from central manifold to camshaft bushes and to rocker arm shaft.

Through the ports and holes, provided in cylinder block, oil arrives by dripping upon valve tappets, on timing gear, on ignition distributor gear, while through other ports oil, which escapes at the extremities of the main journal and crank pin bearings, produce an oil mist in the oil sump room (fine oil drops), which lubricates the other moving parts.

4.1.4.1.1. THE OIL PUMP

The oil pump is a single stage gear pump with inner spur gears and a ratio $Z_1 : Z_2 = 4 : 5$ (see fig. 4.13).

The maximal pump pressure, limited by the pressure control valve (mounted on cylinder block) should be 4.9 daN/cm^2 (71 lbs/in^2).

The maximal pump speed is 2,300 r.p.m.

The bolts, fastening the pump on cylinder block, should be tightened with a 1.5 - 1.8 daNm torque (11 - 13 ft.lbs).

The maximal torque, necessary to rotate the unloaded pump (the rotation should not have a tendency of braking or jamming) should not exceed 2.5 daNm (18.4 ft.lbs).

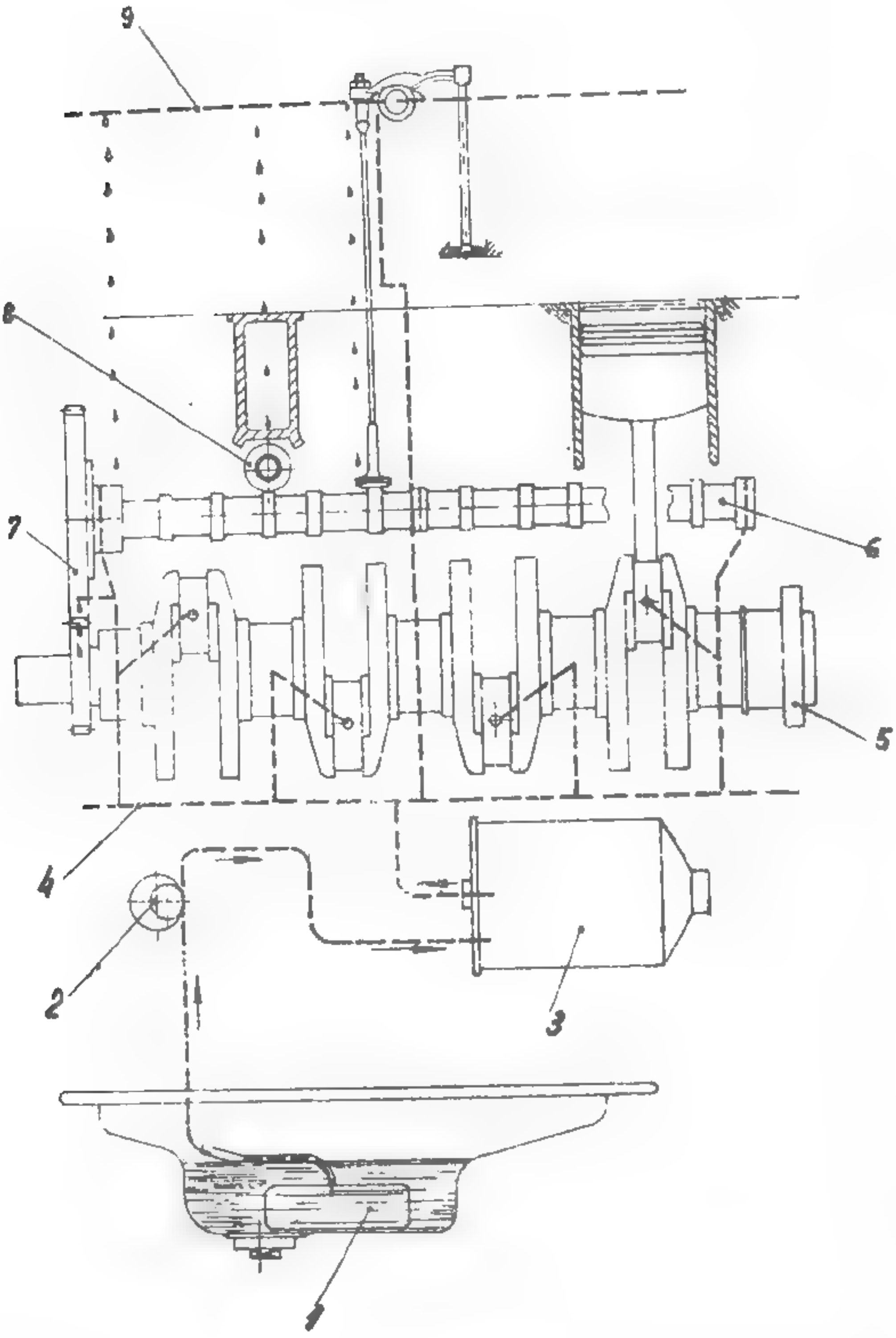


Fig. 4.12. DIAGRAM OF ENGINE LUBRICATION
1. Oil sump strainer; 2. Oil gear pump; 3. Oil filter; 4. Oil central manifold; 5. Crankshaft; 6. Camshaft; 7. Camshaft gear; 8. Ignition distributor driving gear; 9. Rockerarm shaft.

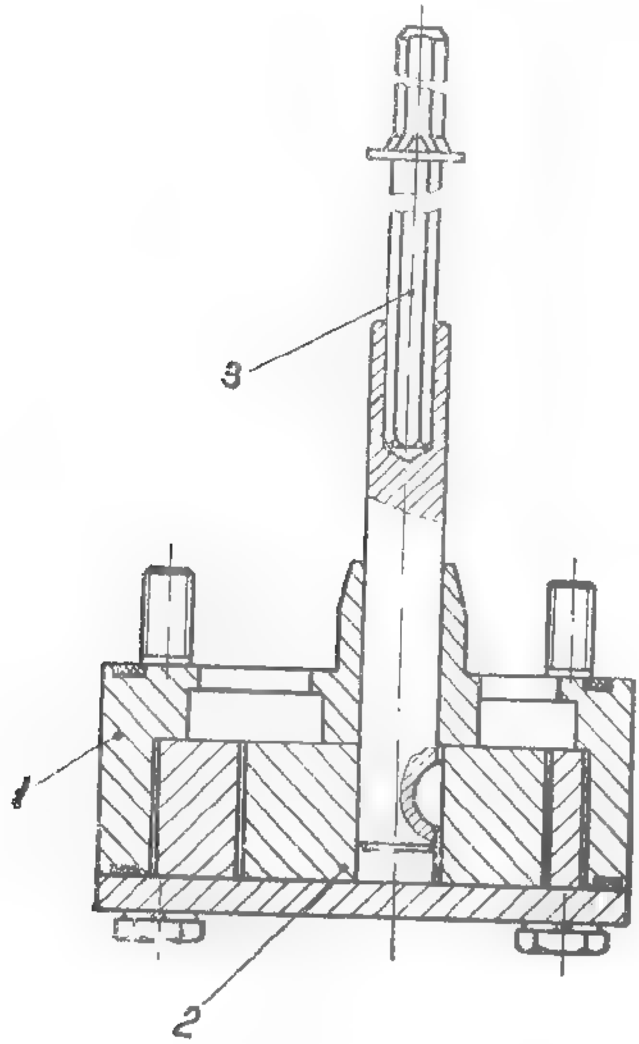


Fig. 4. 13. OIL PUMP

1. Oil pump housing; 2. Inner rotor; 3. Drive shaft

On the pump supply port of ø 1. 5 x 5 mm, the pressure, before the orifice, should be:

- at 1000 r. p. m. .... min 3. 5 bars
- at 250 r. p. m. ....min. 2. 5 bars

The clearance between pump inner rotor and driven gear should be at least 0. 02 mm, going, due to wear, up to max. 0. 130 mm.

4. 1. 4. 1. 2. OIL PRESSURE CONTROL VALVE

The pressure control valve is of plunger type, and, besides the safety relief valve role, it has also a regulating one, maintaining at different pump speeds an adequate pressure in the lubricating system (see fig. 4. 14).

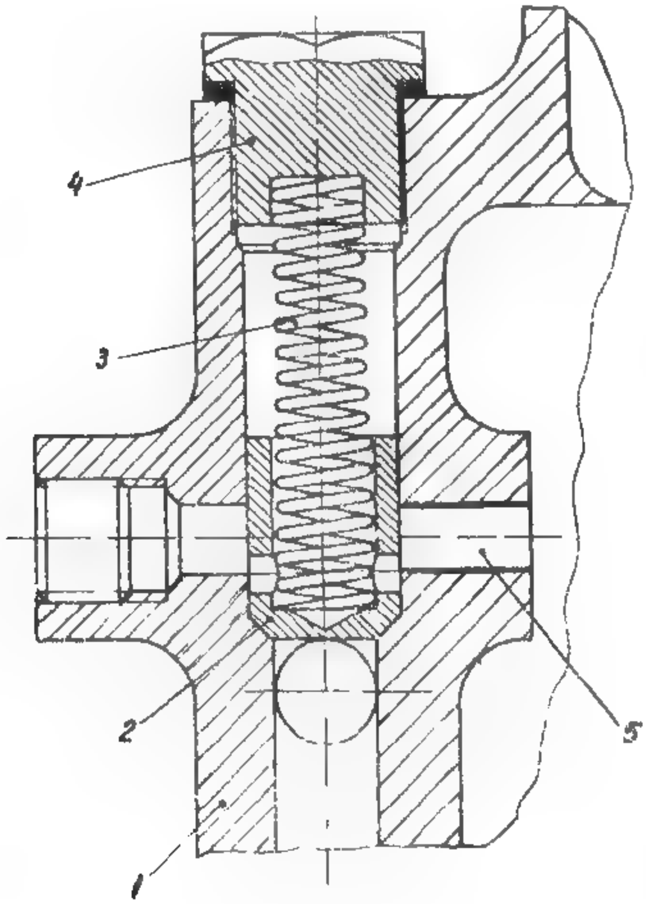


Fig. 4. 14. OIL PUMP PRESSURE CONTROL VALVE.
1. Cylinder block body; 2. Oil relief valve piston; 3. Oil relief valve spring; 4. Screw plug with gasket; 5. Oil relief port.

The pressure control valve begins to open at a pressure of 2.5 daN/cm^2 (35.6 lbs/in^2) and is fully open at 4.9 daN/cm^2 (69.7 lbs/in^2).

The coil spring (3), depressed to 43 mm lenght, is rated for 5.5 - 0.4 daN (12 - 0.9 lbs.) force.

4.1.4.1.4. OIL SUMP

The oil, drawn from the oil sump by the pump, passes throug the rough filtering strainer. In the strainer, connected by a pipe with cylinder bloc there are two filtering gauzes of different fineness, designed to hinder rough impurities to reach the oil pump.

4.1.4.1.5. SUPPLEMENTARY OIL FILTER

Some engines are equipped, on demand, for areas with heavy duty operation conditions, with a second, supplimentary oil filter, interposed before the fine filter, in order retain the rough impurities (50 microns) (see fig. 4.16).

4.1.4.1.6. CENTRIFUGAL FILTER

The carankshaft has collecting hollows, in the transition zones, where oil passes and, owing to centrifugal force oil sets down the finest impurites, which escaped out from the filtering chain.

To clean these collecting hollows, unscrew recessed square plugs secured against slacking by punching.

4.1.4.2. TROUBLES AND REMEDYINGS OF LUBRICATING SYSTEM

Besides the troubles of lubricating system, due to its component units, it can occur other troubles, having repercussions on engine lubricating, such as: oil pollution (Op. 2. 0. 01. 28. 0), inleakages of water or fuel in the oil (Op. 2. 0. 01. 32. 0) through cylinder head gasket (Op. 2. 1. 01. 32. 2), around cylinder linerO-ring gaskets (Op. 2. 0. 01. 32. 1),respectively around the fuel pump hand lever (Op. 2. 0. 01. 32. 1),oil loss by burning(Op.2.0.01 34. 0) causing engine output decrease by reduced compression (Op. 2. 0. 01. 36. 0),or oil leakages through crankshatf rear main bearing (Op. 2. 0. 01. 35. 1), thorugh oil sump gasket(Op.2.0.01.35.2) or through oil filter gasket (Op. 2. 0. 01. 35. 3).

In case that oil pressure is low, although there are no visible oil leakages, check firstly fuel pump for rate of wear (Op. 4. 0. 09. 01. 1), taking it previously down from engine (Op. 2. 0. 01. 33. 0).

If the fuel pump is in good order, the oil pressure diminution is due to too great bearing clearances, the trouble which should be remedyed on general engine overhauling.

The oil pollution can result from failure of oil fine filter, due to faulty by-pass valve or oil filter inner valve (Op. 2. 0. 09. 02. 0 and Op. 2. 0. 09. 03. 0), or from double filtering system failure (Op. 2. 0. 09. 04. 0).

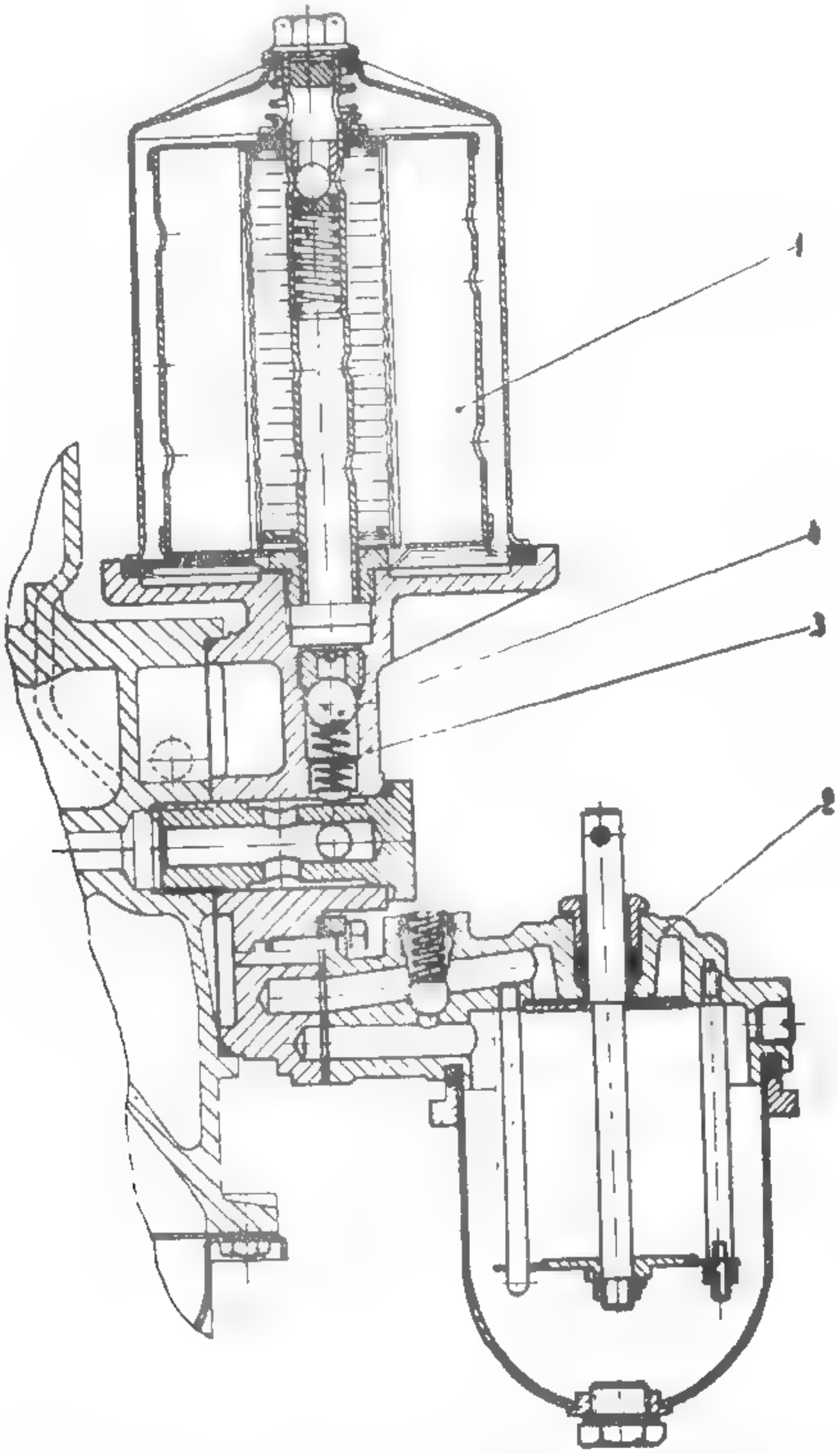


Fig. 4.16. LONGITUDINAL SECTION OF DOUBLE FILTERING SYSTEM.

1. Fine oil filter; 2. Rough oil filter; 3. Intermediate support;

4. One way valve.

OP. 1.0.01.28.0 CHECKING OIL FROM THE ENGINE

- After stopping the engine, pull out oil dip stick and inspect oil aspect the oil should not contain opaque impurities, should not have anormal viscosity or muddy aspect. In case that such aspects are observed, seek for trouble source, according to § 4.1.4.2.

OP. 2.0.01.32.0. CHECKING OIL LEVEL INCREASE

- Pull out the oil dip strick and check oil level on it. If maximal oil level is exceeded, it is a sign that other fluids (water or fuel) have penetrated in the lubricating system. If oil got thinner, it means that fuel has penetrated in it, and the trouble should be remedyed according to Op. 2.0.01.32.1.
- If the oil has maintained its normal viscosity, but has a turbid, muddy aspect, or even fine water drops can be observed in it, it means that water is present in oil and you should seek for causes of water inleakages and after remedying the trouble, change the oil.

OP. 2.0.01.32.2 CHECKING INTEGRITY OF CYLINDER LINER GASKETS

- Inspect on the right side of cylinder block the four small holes (about ∅ 4 mm), provided for eventually water leakages. They are drilled in the area between the two cylinder liner rubber 0-rings. In case that the first (upper) 0-ring got weakened, on respective cylinder block face appear water leakages, marked by rust traces. It is an alert sign, because it gets possible that the second (lower) 0-ring could also weaken, causing certainly water inleakage into oil sump.
- In such a case both 0-rings of respective cylinder liner should be replaced (see Op. 2.1.02.03.0).

OP. 2.1.01.32.2 CHECKING TIGHTNESS BETWEEN CYLINDER HEAD AND CYLINDER BLOCK

- Drain oil from engine oil sump, according to Op. 1.0.01.03.0.
- Take down cylinder head, acc. to Op. 2.0.01.21.1.
- Take down exhaust manifold, acc. to Op. 2.0.08.04.0.
- Take down air cleaner adapter from carburettor (Op. 2.0.01.15.1).
- Take down carburettor from inlet manifold (Op. 2.0.08.05.0)-
- Take down thermostat elbow, acc. to Op. 2.0.07.02.0.
- Take down inlet manifold, acc. to Op. 2.0.08.06.0.
- Take down rocker arm shaft assembly, acc. to Op. 2.1.01.29.0.
- Drain water from cooling system, acc. to Op. 2.0.13.04.0.
- Take down water pump, without taking down the engine from vehicle, acc. to Op. 2.1.01.37.0.
- Take down cylinder head from engine block, acc. to Op. 2.1.01.30.0.
- Check firstly the aspect of cylinder head gasket, for fissures between passes for oil and water (from engine block into cylinder head) or for rust traces, connecting these passes, marking so water leakages between the passes.
- If gasket will be found faulty, it should be changed with a new one.

  In case that there will be found two rust traces it means that the cylinder head was not enough tightened on cylinder block or cylinder - head surface or that of cylinder block is not flat. In that case:
- Check flatness of cylinder head by means of a metallic rule and a feeler gauges set, so as it is shouwn in the fig. 4.17:
- The maximal allowed deviation is of 0.035 mm/100 mm and max. 0.1 mm on the whole cylinder head lenght. If it is exceeded it is allowed to true up the cylinder head mounting surface, according to indications conserning general engine overhauling.
- Performe the same checking on cylinder block mounting surface.

  If the trouble persists (i.e. water leakages), a complex checking of cylinder head is necessary, for fissures in its material. This checking is performed on general overhauling of the engine.

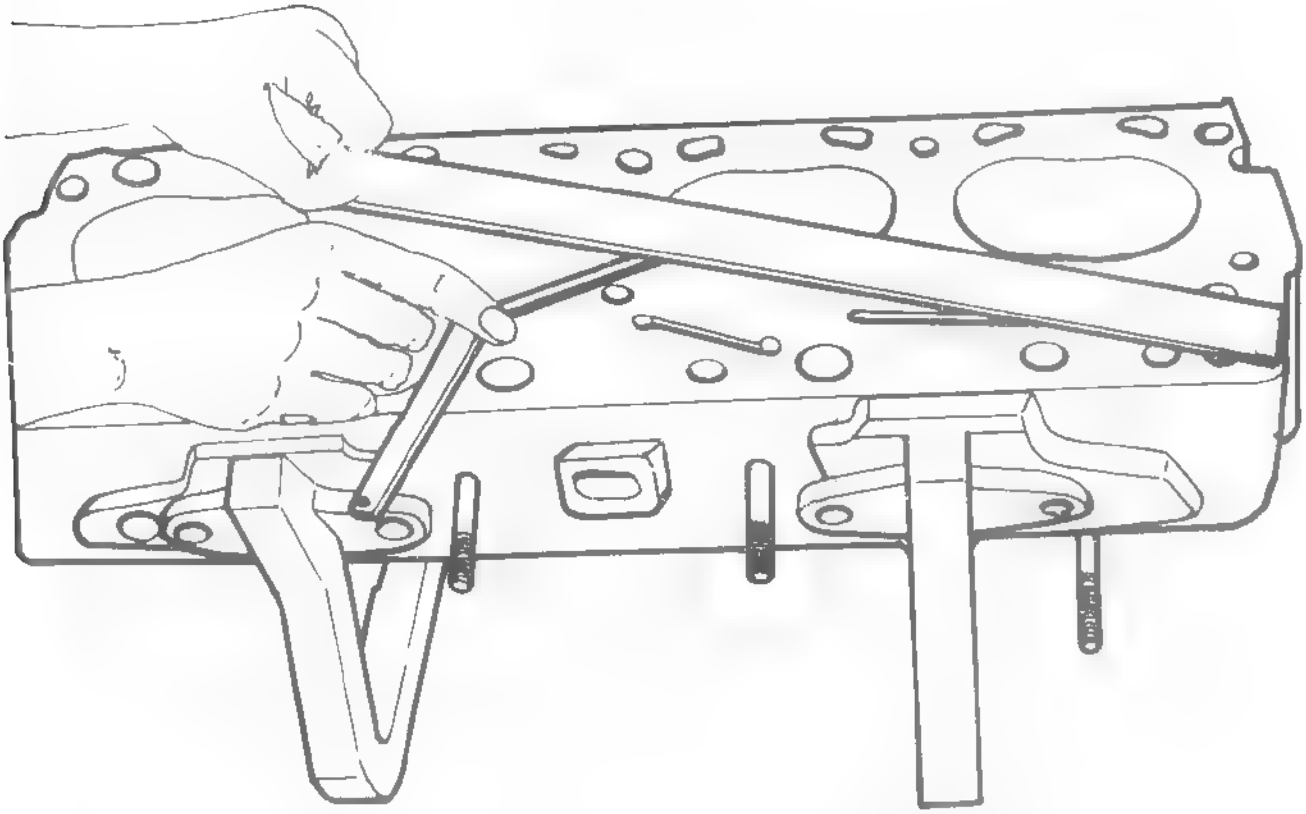


Fig. 4. 17. CHECING FLATNESS OF CYLINDER HEAD

- Refit all assemblies in reverse order, tightening cylinder head according to Op. 2. 0. 01. 17. 0, and all other bolts with torques indicated in Table VII.
- Fill fresh, adequate oil into engine sump.
- Fill cooling system with water or antifreeze fluid, acc. to Op. 2. 0. 13. 09. 0.
- Start engine for a test operation, following cylinder head gasket tightness, observing the small control holes on cylinder block for eventually water leakages. Check oil level and aspect in the sump, cooling fluid in expansion vessel or in cooling radiator, for oil films.

OP. 2. 0. 01. 34. 0 ESTIMATING IGNITION PROCESS ACCORDING TO EXHAUST GASES APPEARANGE

Normally, the exausted fumes from rear muffler pipe should be colourless or, in winter, in frosty weather, it should contain water vapours,

which evaporate again and vanish in the atmosphere.

If exhausted fumes are black, it means there there are carburation troubles, caused by overriched mixture, or retarded ignition.

If exhausted fumes are whitish, it means that there are troubles in lubricating system, i.e. oil reaches combustions chambers, most frequently due to untightness of piston rings. For certainty's sake, perform the checking of cylinders compression, according to Op. 2.0.01.36.0.

OP. 2.0.01.36.0 CHECKING COMPRESSION PRESSURE

In case that valve clearance is right and the valves close correctly, unsscrew the spark plug of checked cylinder and fit instead it a pressure gauge (manometer). Then, by cranking the engine, bring piston in its upper dead center (compression position) and follow on pressure gauge the cylinder pressure, which should decrease only very slowly.

- In case that the pressure decreases quickly, check piston - cylinder assembly and replace faulty components, as indicated on chacking clearances between piston rings and piston grooves (see Op. 4.1.04.03.0).

OP. 2.0.01.35.1 CHECKING REAR MAIN BEARING FOR OIL LEAKAGES

Inspect from underside of vehicle if there are no oil leakages around the oil filter. If oil leakages are abundant, the oil filter gasket should be replaced, acc. to Op. 2.0.09.05.0.

OP. 2.1.01.38.0 CHANGING SUMP GASKET

- Drain out oil from oil sump, acc. to Op. 1.0.01.03.0
- Getting access from underside of vehicle, unscrew all bolts which fasten oil sump on cylinder block. Remove the sump and its gasket.

- Wash oil sump from all impurities, settled on it.
- Refit oil sump on engine block, using a new, original gasket and tightening bolts with a torque of 1.7 - 2 daNm. (12.5 - 14.7 ft.lbs)
- Refill engine with fresh, adequate oil.

OP. 2.0.01.33.0 TAKING DOWN THE OIL PUMP

- Drain lubricating system acc to Op. 1.0.01.03.0.
- Unscrew the four bolts, fastening the oil pump on engine block, and remove the pump.

  Pay special attention for 0-ring gaskets; if deformed, they should be replaced by original parts.
- On refitting tighten bolts with a torque of 1.7 - 2 daNm (kgm). (12.5 - 14.7 ft.lbs)

OP. 4.0.09.01.1 CHECKING OIL PUMP FOR RATE OF WEAR

The oil pump troubles can result from the wear of its components or wrong mounting. Due to wear the pump cannot provide necessary supply and pressure. In this situation:

- Take down the oil pump from engine, acc. to Op. 2.0.01.33.0.
- Check frontal play of both gears, which should be comprised between 0.035 and 0.130 mm. The radial play should be max. 0.130 mm. In case of gear wear, replace both gears. The central, driving gear, is pressed on the driving shaft and secured with a pin.
- Another trouble may occur by oil leakages at the pump joint on the engine block or at the pump cover, due to twisted ar faulty gaskets. In this case replace the gaskets with original parts.
- After refitting the oil pump on engine, fill engine sump with fresh, adequate oil.

OP. 2.0.09.02.0 CHECKING AND REMEDYING OIL PRESSURE CONTROL VALVE

The valve plunger can get jammed due to impurities or decalibrated (or even briken) spring. To remedy the trouble:

- Unscrew the plug (4) - see fig. 4.14 - and remove it with its gasket.
- (Do it an hour after engine stopping).
- Remove piston spring and check it, verifying its camber, refered to its force. If the spring is decalibrated or broken, replace it with a new, original spring.
- If the valve plunger is jammed, spray it with white-spirit or another organic solvent, remove it, wash all components in white-spirit and refit all in reverse order.
- Refit pressure control valve on engine block.

OP. 2.0.09.03.0 CHECKING AND REMEDYING OIL FINE FILTER

Normally the oil fine filter does not get faulty; only the filtering elements get worn by clogging with impurities, and should be replaced with a new one, or the sealing gasket can get broken.

If, in case of an accident, the filter box was deformed, the whole filter should be replaced with a new one.

To remedy a faulty filter it should:

- Drain the engine lubricating system, acc. to Op. 1.0.01.03.0.
- Unscrew filter center shft (6) - see fig. 4.15 - and remove the whole assembly.
- Remove from filtar box (4) the filtering element (5), center shaft gasket (8) and positioning oil spring (7).
- Remove centershaft (6) from filter box.
- Unscrew from cylinder block assembling nut (2) and remove filter box seat with gasket (1). Remove faulty gasket (3).

- Fit on the filter box seat periphery a new gasket (3).
- Fit back filter box seat (1), having the two holes upwards, on cylinder block, fastening it with the assembling nut.
- Refit all filter components in reverse order.
- Refit filter on cylinder block and tighten center shaft with a torque of 2, 5 - - 3, 5 daNm (kgm). (18, 4 - 25, 8 ft. lbs)
- Refill engine with fresh, adequate oil.

OP. 2. 0. 09. 04. 0 CHECKING AND REMEDYING OIL DOUBLE FILTERING SYSTEM

- Drain engine lubricating system, acc. to Op. 1. 0. 01. 03. 0.
- Take down fine oil filter (1) from intermediate support (3) - see fig. 4. 16. -
- Unscrew special bolt, fastening the support on engine block. Remove support and its 0-ring sealing gasket.
- Remove from intermediate support rough oil filter (2), together with its gasket.
- Remove from intarmediate support the closing plugs.
- Unscrew from support, in the setting area of the fine filter, the one-way valve seat, and remove the valve ball together with its closing spring. The spring should be calibrated for 0. 1 daN (kg), at 21. 8 mm lenght and for 0. 2 daN at 17. 6 mm lenght.
- <u>Dismantle rough oil filter as follows:</u> (see fig. 4. 18)
- Unscrew the four bolts, fastening the filter sediment bowl (2) on filter body (1).
- Remove sealing gasket (3).
- Remove, by unscrewing, shorting pressure control valve cap (4) and remove valve spring (5) and valve ball (6).

  The spring should be calibrated for 0. 7 $\pm$ 0. 1 daN (kg) at 43 mm, respectively for 2. 5 $\pm$ 0. 35 daN at 16. 3 mm lenght.

  In case that there are oil leakages around the central rod (8), although the the packing gland was tightened up to refuse (9), the latter should be unscrewed and its packing changed (10).

  NOTE: 1 daN = 1,02 kg = 2,2 lbs.

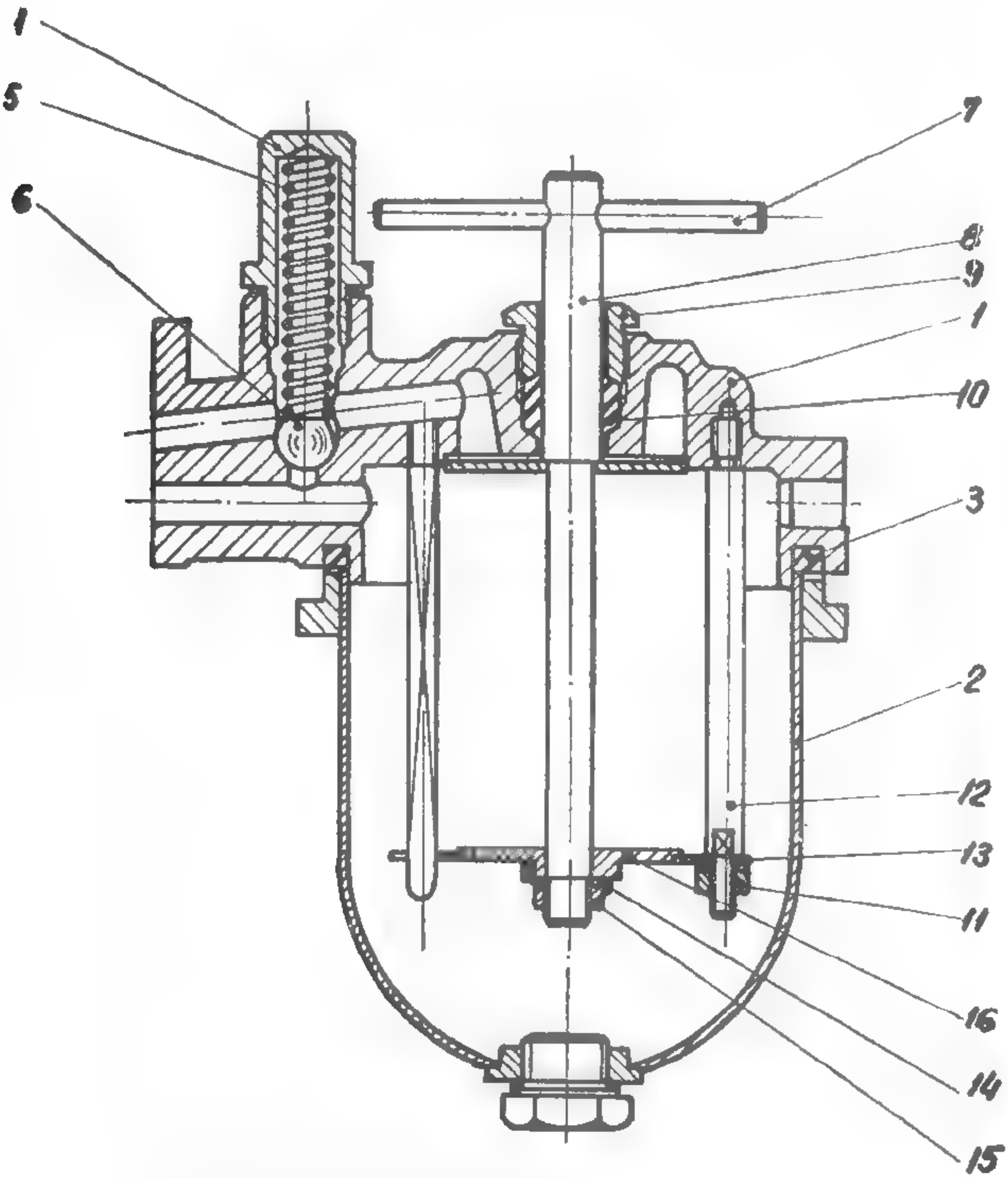


Fig. 4.18. SECTION OF ROUGH OIL FILTER.
1. Rough filter body; 2. Sediment bowl; 3. Bowl gasket; 4. Shorting pressure control valve; 5. Valve spring; 6. Valve ball; 7. Central rod handle; 8. Central rod; 9. Packing gland; 10. Packing; 11. Nut; 12. Lateral rod; 13. Backing plate; 14. Lock washer; 15. Central rod nut; 16. End disk.

Only in extreme case, when the filter got blocked up (the center rod cannot be ratated), even after and abundant washing, performe dismantling of filtering blades (159 blades). For this:

- Unscrew the three nuts (11), removing them from lateral rods (12), and removing spring washers and backing plate (13).
- Undo central rod lock washer (14). After that, unscrew central rod nut (15) and remove lock washer and end disk (16).
- Remove, one by one, the filtering rosettes, spacers and centring plates, from the central square shaft, untill the faulty pieces will be found and removed.
- Replace faulty filtering rosettes with new, original parts, or, if there are less than 2% deteriorated pieces, you can give them up.
- Refit rough oil filter in reverse order to that on dismantling.
- Refill engine with fresh, adequate oil.

OP. 2. 0. 09. 05. 0 REPLACING GASKET OF FINE OIL FILTER

- Drain engine lubricating system, acc, to Op. 1. 0. 01. 03. 0.
- Unscrew center shaft (6) - see fit. 4. 15 - and remove it together with filter box.
- Unscrew from cylinder block assembling nut (2) and remove filter box seat (1), having sealing rubber gasket around it (3).
- Replace faulty gasket with a new, original one.
- Refit all filter components in reverse order; take care that the filter box seat shoudl have its two holes positioned upwards on cylinder block.
- Refill engine with fresh oil.

4. 1. 5. TROUBLES AND REMEDYINGS OF THE COOLING SYSTEM, MOUNTED ON THE ENGINE

The water pump is of single-stage, centrifugal type, serving to forced circulation of cooling water, inside the engine. It is driven by the engine, by the agency of a V-belt.

At a speed of 2200 $\pm$ 50 r.p.m. and at a static pressure, measured between the pump inlet and outlet, of 550 mm Hg (mercury column), the pump discharge is 6500 litres p. hour.

Maximal speed of the pump is 4.800 r.p.m.

The characteristics of the pump, at different speeds, are given in graph (fig. 4.19).

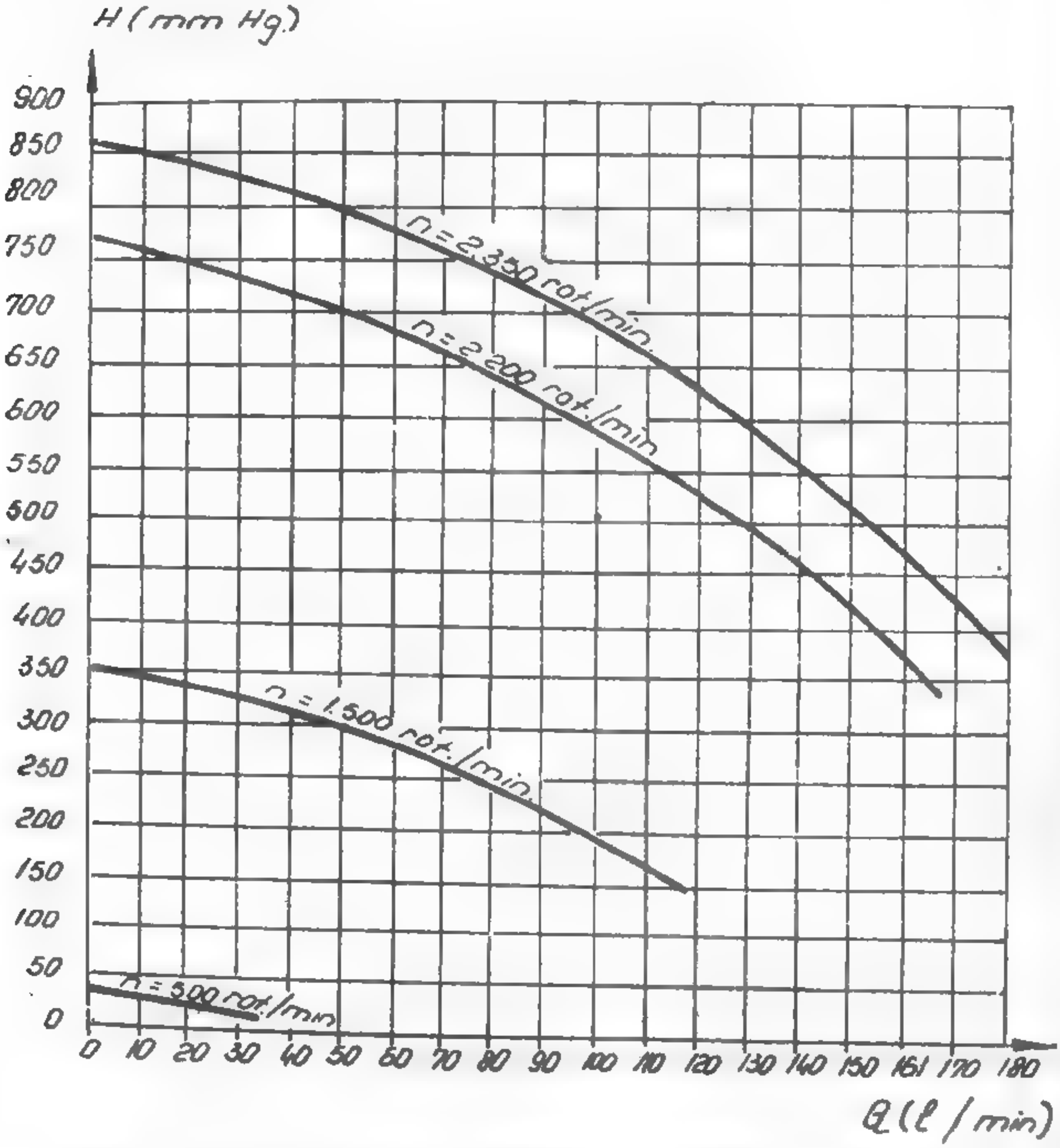


Fig. 4.19. WATER PUMP CHARACTERISTICS AT DIFFERENT SPEEDS AND STATIC PRESSURES.

The pump body is an aluminium casting. Its shaft is fitted with two shielded, selflubricating ball bearings (9) - see fig. 4. 20 -

On the flange, fitted on the pump shaft, is fastened the cooling fan and pump driving pulley, securing the air circulation around the engine.

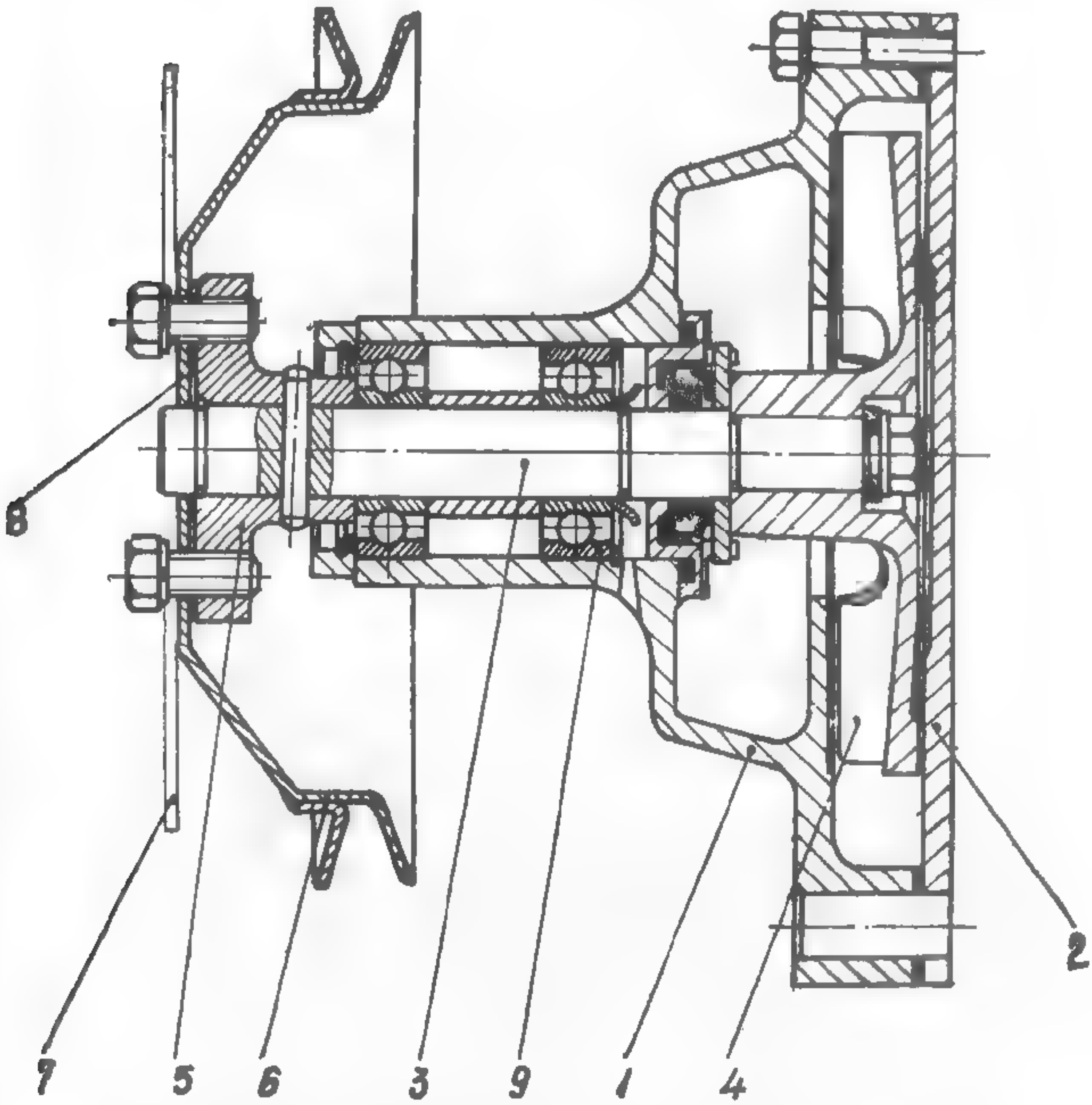


Fig. 4. 20. WATER PUMP
1. Pump housing; 2. Pump housing cover; 3. Water pump shaft; 4. Pump impeller; 5. Pulley flange; 6. Water pump pulley; 7. Cooling fan; 8. Shim for adjusting pulley plane position; 9: Shielded ball bearing.

nen closed, i.e. up to 82°C (180°F) water temperature, the thermostat eads water through the engine. At 82°C the thermostat begins to open, securing mixed water circulatio, through the engine and through the radiator. At 90°C (194°F), thermostat is completely open, i.e. 10.5±1 mm, and leads the water flow through the cooling radiator.

The thermostat is located in elbow of inlet manifold and by the agency of a hose it provides the heating of inlet manifold.

When the water temperature decreases up to + 78°C (172,4°F), the thermostat closes again the flow to radiator. The allowed temperature deviations are ± 2°C.

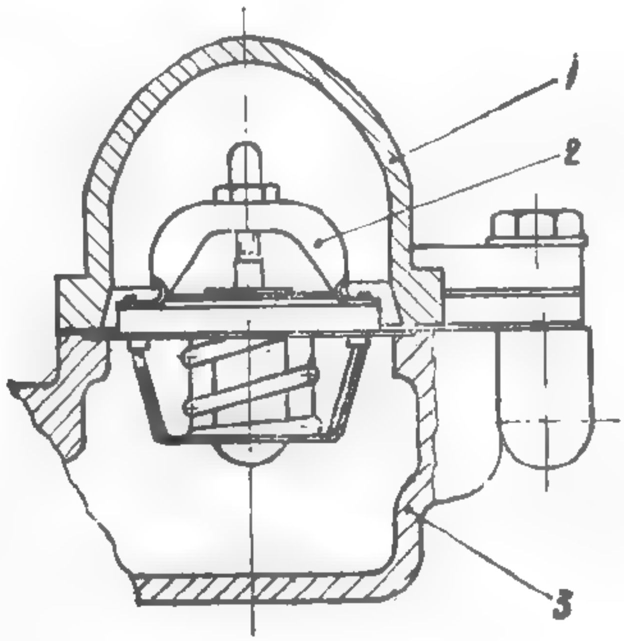


Fig. 4.21. ENGINE THERMOSTAT
1. Thermostat cover; 2. Thermoregulator; 3. Thermostat body.

4.1.5.2. TROUBLES AND REMEDYINGS OF THE ENGINE COOLING SYSTEM

- The cooling system trobules are severe as lubricating system troubles, because they cause the engine overheating and the danger of engine seizure.

  Due to damage of the gasket between the water pump housing and its cover, water leakages can occur; in this case the pump should be taken down and the faulty gasket replaced (see Op. 2.1.01.37.0).
- If the gland, sealing the pump shaft, is worn out, causing water leakages around the shaft, the gland should be replaced (see Op. 2.1.07.03.0).
- When, after a lomg operation the two pump bearings get worn out, causing anormal noises, they should be replaced.
- If, due to casting flaws an impeller blade gets accidentally broken, the impeller should be immediately replaced (see Op. 2.1.07.05.0).
- If thermostat does not correctly operate or is jammed, the engine will get overheated. The faulty thermostat should be checked and, eventually replaced (see Op. 2.0.13.05.0)
- Check also all hose connections for tightness on inlet manifold, thermostat, water pump and other cooling system units (see Op. 2.0.13.06.0).
- If water leakages will appear around the small, free holes on the right side of cylinder block (in the car driving sense), it shows that some cylinder liner sealing 0-rings are damaged and it is necessary to replace faulty 0-rings (see Op. 2.1.07.01).

OP. 2. 1. 01. 37. 0 TAKING WATER PUMP DOWN, WHEN ENGINE IS ON THE CAR

- Drain cooling system, according to Op. 2. 0. 13. 04. 0.
- Disconnect and remove expansion vessel (if the cooling system is of sealed type), acc. to Op. 2. 0. 13. 06. 1.
- Disconnect water pump from hoses leading to thermostat and the heating system.
- Disconnect water pump from radiator outlet hose (connected to radiator lower tank).
- Slacken alterantor V-belt tensioner and remove V-belt.
- Unscrew bolts fastening fan cowling, which should be removed over the fan and water pump.
- Unscrew bolts fastening the fan on the pump pulley and remove it and the pulley.
- Unscrew the three bolts fastening the water pump and remove it together with the fan cowling.
- After having performed the pump repair, refit all in reverse order.
- Refill engine with cooling fluid, according to Op. 2. 0. 13. 09. 0.
- After starting the engine, inspect and check the cooling system for its tightness, according to Op. 2. 0. 13. 06. 0.

OP. 2. 1. 07. 03. 1 REPLACING GASKET OF WATER PUMP HOUSING COVER.

- Take water pump down from the engine, acc. to Op. 2. 1. 01. 37. 0, after having previously drained the cooling system, as described in Op. 2. 0. 13. 04. 0 and disconnected expansion vessel, acc. to Op. 2. 0. 13. 06. 1.
- Unscrew bolts fastening the cover on the pump housing.
- Remove the cover and its gasket.
- Replace the faulty gasket and refit all in reverse order.
- Refill cooling system with cooling fluid, acc. to Op. 2. 0. 13. 09. 0.

Start the engine and check if there are no fluid leakages, as described in Op. 2.0.13.06.0.

OP. 2.1.07.03.0 REPLACING THE GLAND OF WATER PUMP SHAFT

- Drain the cooling system, acc. to Op. 2.0.13.04.0.
- Disconnect and remove the expansion vessel (if the vehicle has a sealed cooling system), acc. to Op. 2.0.13.06.1.
- Take water pump down from engine, as described in Op. 2.1.01.37.0.
- Remove pump housing cover, together with its gasket, without damaging the latter.
- Clamp up the shaft driving flange in a parallel bench vice and unscrew the nut securing the pump impeller on the shaft.
- Remove spring lock washer, thrust washer and the shaft gasket; remove then the pump impeller from the shaft.
- Remove textolite sealing washer and draw out the rubber gasket together with the pressure spring.
- Replace rubber gasket with a new, original one and refit the pump in reverse order.
- Refit the pump on the engine and refill the cooling system, according to Op. 2.0.13.09.0.
- Start the engine and check its cooling system for fluid leakages, as described in Op. 2.0.13.06.0.

OP. 2.1.07.04.0 REPLACING WATER PUMP BALL BEARINGS

- Drain cooling system acc. to Op. 2.0.13.04.0.
- Disconnect and remove expansion vessel (if vehicle has sealed cooling system), acc. to Op. 2.0.13.06.1.
- Take water pump down from the engine, as described in Op. 2.1.01.37.0.
- Remove the pump housing cover.

- Clamp up the shaft driving flange in a parallel bench vice and unscrew nut securing the pump impeller on the shaft.
- Remove spring lock washer, thrust washer, shaft gasket, impeller and the gland.
- Drill out the rivetted dowel pin, securing the driving flange on the pump shaft, drepress it and finkly draw out the flange from the shaft.
- Remove snap ring - see fig. 4.20 -, by the agency of nose pliers and draw out annular shim from the shaft flange end.
- Draw out the shaft, together with both bearings (see fig. 4.22), from the pump housing.

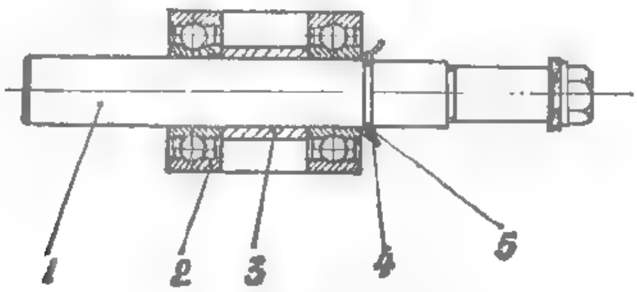


Fig. 4.22. WATER PUMP SHAFT
1. Pump shaft; 2. Half-sealed ball bearing; 3. Spacer sleeve; 4. Water deflector; 5. Snap ring.

- Adjust the hole for dowel pin, in order to remove any burr.
- Remove the outer bearing from the shaft.
- Remove the spacer sleeve from the shaft.
- Extract, by the agency of a press, the second bearing from the shaft.

On mounting new bearings perform operations in following order:

- Press inner bearing on the shaft, up to water deflector (5) (fig. 4.22).
- Extract from the pump housing the gland cage.
- By the agency of a hydraulic press deprees the shaft, together with inner bearing, into the pump housing, untill the bearing outer race touches on the snap ring.
- Fit on the shaft the spacer sleeve.

- Press the second bearing, also by means of a press

  ATTENTION! On pressing the bearings in the pump housing, sit it on the gland cage back edge, in order to evoid the pump housing deformation.

- Fit upon the outer bearing the annular shim and after it, the snap ring.
- Fit on the shaft the driving flange and secure it with a new dowel pin (Ø 5 x x 32), riveting it at both ends.
- Fit on the opposite end of the shaft the gland, the shaft sealing gasket, the pump impeller, again the shaft gasket, washer, spring lock washer. Tighten finaly all components with the nut, using a moderate torque.

  Further the mounting should be performed in reverse order as on taking pump down,

- Refill cooling system with cooling fluid, acc. to Op. 2. 0. 13. 09. 0.
- Check cooling system for for fluid leakages, acc. to Op. 2. 0. 13. 06. 0.

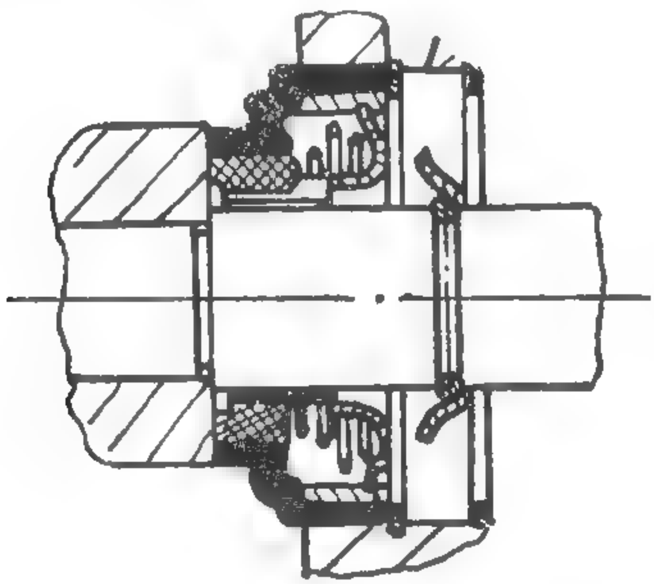


Fig. 4. 23. WATER PUMP SHAFT SEALING GLAND (VERSION).

OP. 2. 1. 07. 05. 0 REPLACING WATER PUMP IMPELLER

- Drain cooling system, according to Op. 2. 0. 13. 04. 0.

- Disconnect and remove expansion vessel (if the vehicle has a sealed cooling system) according to Op. 2. 0. 13. 06. 1.
- Take down the water pump from engine, as described in Op. 2. 1. 01. 37. 0.
- Remove pump housing cover, together with its gasket.
- Unscrew the nut securing impeller on the shaft and remove the thrust washer and the shaft gasket.
- Draw out the pump impeller.

  After fitting the new, original impeller, refit all components in reverse order.
- Refill cooling system with cooling fluid, accordint to Op. 2. 0. 13. 09. 0.
- Check cooling system for fluid leakages, acc. to Op. 2. 0. 13. 06. 0.

OP. 2. 0. 07. 02. 0. DISMANTLING THERMOSTAT ELBOW

- Drain cooling system, acc. to Op. 2. 0. 13. 04. 0.

  If it will be necessary to perform an intervention on thermostat, it is sufficient to unscrew the two bolts which fasten the thermostat elbow. The latter, with its flange fastens the thermostat collar.

  If thermostat housing has some pores, or if from some other reasons it will be necessary to take thermostat elbow down, disconnect firstly connecting hoses, leading to inlet manifold, water pump and cylinder head. Then, unscrew the two bolts and remove thermostat housing, assembled with the connecting elbow, removing also respective gasket. Once taken down, the thermostat housing assembly can be disassembled, in order to take thermostat out.
- Refit all components in reverse order.
- Refill cooling system with cooling fluid, acc. to Op. 2. 0. 13. 09. 0.
- Check cooling system for fluid leakages, acc. to Op. 2. 0. 13. 06. 0.

OP. 2. 1. 07. 01. 0. REPLACING CYLINDER LINER O-RING GASKET

- Drain engine lubricating system, acc. to Op. 1. 0. 01. 03. 0.
- Drain engine cooling system, acc. to Op. 2. 0. 13. 04. 0.

- Disconnect carburettor from the fuel pump and acceleration throttle control mechanism.
- Undo connections between cylinder head and air cleaner, between cylinder head and thermostat elbow, between carburettor and air cleaner.
- Undo connection between cylinder head and heating system.
- Remove cylinder head cover, acc. to Op. 2. 0. 01. 21. 1.
- Take rocker arm shaft down, acc. to Op. 2. 1. 01. 29. 0.
- Disconnect muffler exhaust fore pipe.
- Take assembled cylinder head down.
- Getting access from underside of vehicle, take engine oil sump down, removing it together with its gasket.
- Turn engine crankshaft, by the agency of the starting hadnle, bringing crankpin of respective cylinder (where water leakage occured) in its lower position (outer dead centre).
- Unscrew big end cap bolts of respective piston rod.
- Remove big end cap, using slight blows by means of a rubber or plastic hammer.
- Turn again the crankshaft, in order to bring the piston in its inner dead centre.
- By means of a wooden rod (for instance, the rubber hammer shaft), blow slightly on the piston bottom (from inside of engine), so that piston with its rings goes out of cylinder.
- Remove the piston, put it on a bench, with the piston rod upwards, and set big end cap on its bolts, in order to not uncouple both big end half bearings.
- Draw out respective cylinder liner by means of special D 303, extractor.
- Replace faulty 0-ring gasket, fitting a new, original one in its groove (on cylinder liner).

ATTENTION. Before fitting the new 0-ring gasket, check respective groove edges for burrs, which could damage the new gasket, on passing over them. If some burrs will be found, clean them by means of a scraper, taking care to remove all resulted cuttings.

- Wet both 0-rings with solution of soap in water, and refit cylinder liner into engine block, using special D 304 device.
- Further, perform refitting of all components in revrse order, following the below griven indications:
- On introducing the piston with its rings use S 17 assembling sleeve.
- The nuts securing big end cap should be tightened with a torque wrench, adjusted for a torque of 6.5 - 7.0 daNm (kgm). (48 - 51.6 ft. lbs)
- On tightening bolts which fasten cylinder head on the engine block should be observed the indications given in Op. 2.0.01.17.0.
- Refill engine with oil, according to Op. 1.0.01.03.0.
- Refill engine cooling system with cooling fluid, acc. to Op. 2.0.13.09.0.
- Check cooling system for its tightness, acc. to Op. 2.0.13.06.0.

OP. 2.1.07.01.1 REPLACING CYLINDER LINER 0-RING GASKET OF ANOTHER CYLINDER, DURING THE REPAIR OPERATION 2.1.07.01.0.

- Crank the engine, by means of the starting handle, untill the crank pin of respective cylinder reaches its lower position (outer dead centre), and perform the same operations of dismantling and replacing faulty 0-ring gasket, as above described (Op. 2.1.07.01.0).
- After this second intervention refit engine in reverse order.

4.1.6. TROUBLES AND REMEDYINGS OF ENGINE ELECTRIC EQUIPMENT

4.1.6.1. DESCRIPTION OF ENGINE ELECTRIC EQUIPMENT

The engine electric equipment consists of:

1. Ignition system, including ignition distributor, ignition coil, H.T. lead set and spark plugs.
2. Alternator.
3. Starting motor.

4.1.6.1.1. IGNITION SYSTEM

The ignition distributor provides the jump of spark in due, optimal time, by an adjusting depending on engine load (vacuum controlled advance, depending on vacuum in the inlet manifold - see fig. 4.24. and on engine speed (centrifugal advance - see fig. 4.25).

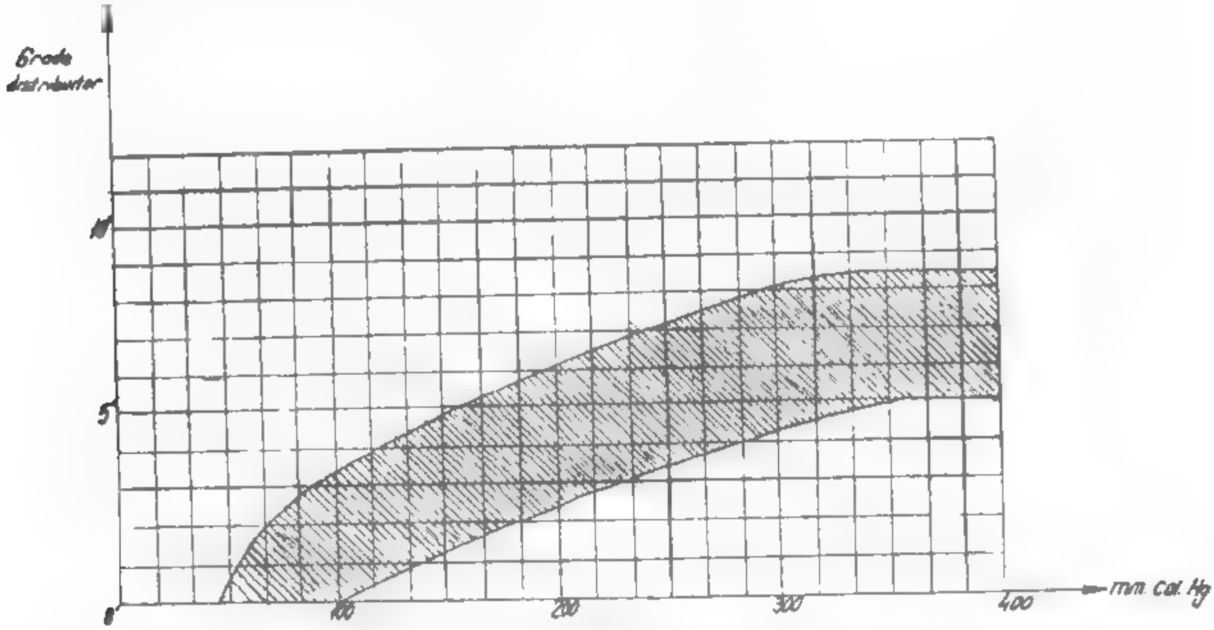


Fig. 4.24. DIAGRAM OF AUTOMATIC IGNITION ADVANCE ANGLE CHANGING, DEPENDING ON PRESSURE (VACUUM CONTROLLED ADVANCE).

- Advance angle = f (mm Hg. pressure)

The distributor breaker points are parallel and are pressed with a force of 0,45 $\pm$ 0,1 daN (kg). (1,12 $\pm$ 0,24 lbs)

The distributor insulating cover can endure without breakdown an electric voltage of 12,000 V and 50 Hz (at a temperature of 80^{o}C) between H.T. distributor plugs and the ground (vehicle body).

The ignition coil is fitted on the vehicle body, below the bonnet.

The starting motor has a nominal output of 1,4 kW and is provided with a motor coupling electromagnetic mechanism on

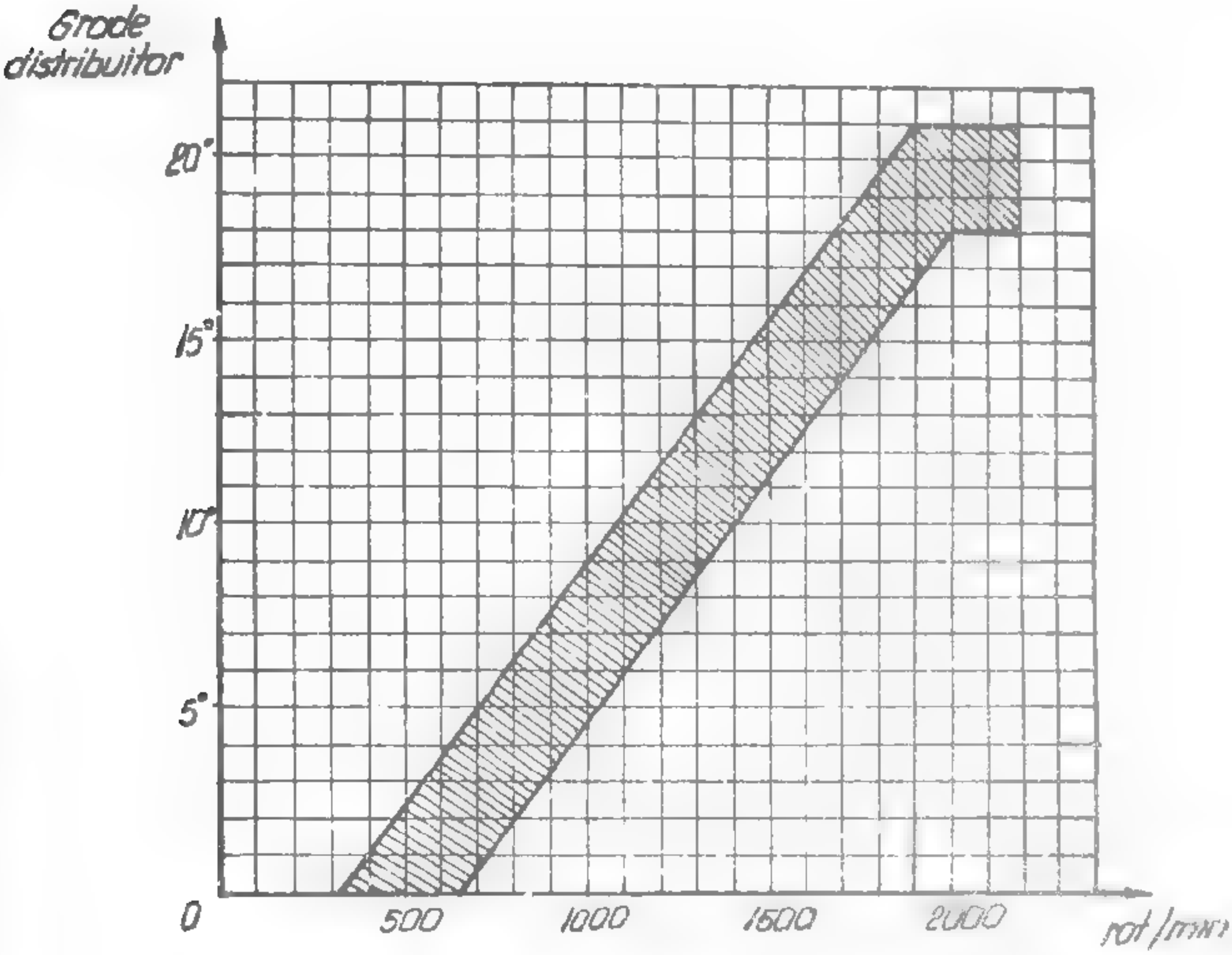


Fig. 4. 25. DIAGRAM OF AUTOMATIC IGNITION ADVANCE ANGLE CHANGING, DEPENDING ON ENGINE SPEED (CENTRIFUGAL ADVANCE)

starting engine, and throwing out, by force of inertia, when engine starts. On unloaded running the starting motor has a speed of min. 4,000 r.p.m. and needs a current of 90 Amp.

On maximal load (braking torque of 1.8 daNm), its terminal voltage can decrease up to 5 V, at a maximal current of 550 Amp.

The maximal motor speed, allowed for 20-sec., is 76000 r.p.m.

The Bendix drive maintains the coupling with the engine up to engine speed of 310 ... 390 r.p.m. (or a starting motor speed of 5100 ... 6300 r.p.m. respectively); over this speed decoupling occurs automatically.

The maximal wears, allowed for the starting motor components, are:

- for commutator diameter: max. 1 mm
- for armature shaft journals diameter: max. 0.2 mm
- for bronze bushes inside diameter: max. 0.15 mm
- for steel bush inside diameter: max. 0.3 mm

The brushes should be changed after a wear of 50% of their initial height or after 12,000 startings (about 3 years vehicle operation).

The three-phase alternator, (see fig. 4.26), operates together with voltage regulator, type 1410, and the storage battery of 12 V terminal voltage. Both alternator and regulator are produced by UEPS - factory.

ALTERNATOR MAIN FEATURES:

- Nominal voltage	12 V
- Maximal output	500 W
- Necessary speed to begin current supplying at 14 V	950 r.p.m.
- Supplied current at 14 V and 3000 r.p.m. in steady state	30 A
- Maximal exciting (field) current	3.2 A
- Maximal continuous speed	10,000 r.p.m.
- Overspeed	12,000 r.p.m.
- Field coil resistance between the two slip rings, at 20°C	4.7 Ohms
- Sense of rotation	indifferent

These features are stated with brushes having the contact su face completely shaped

As shown in the graph (fig. 4.27), the magnetizing coil is powered from storage battery, by the agency of voltage regulator.

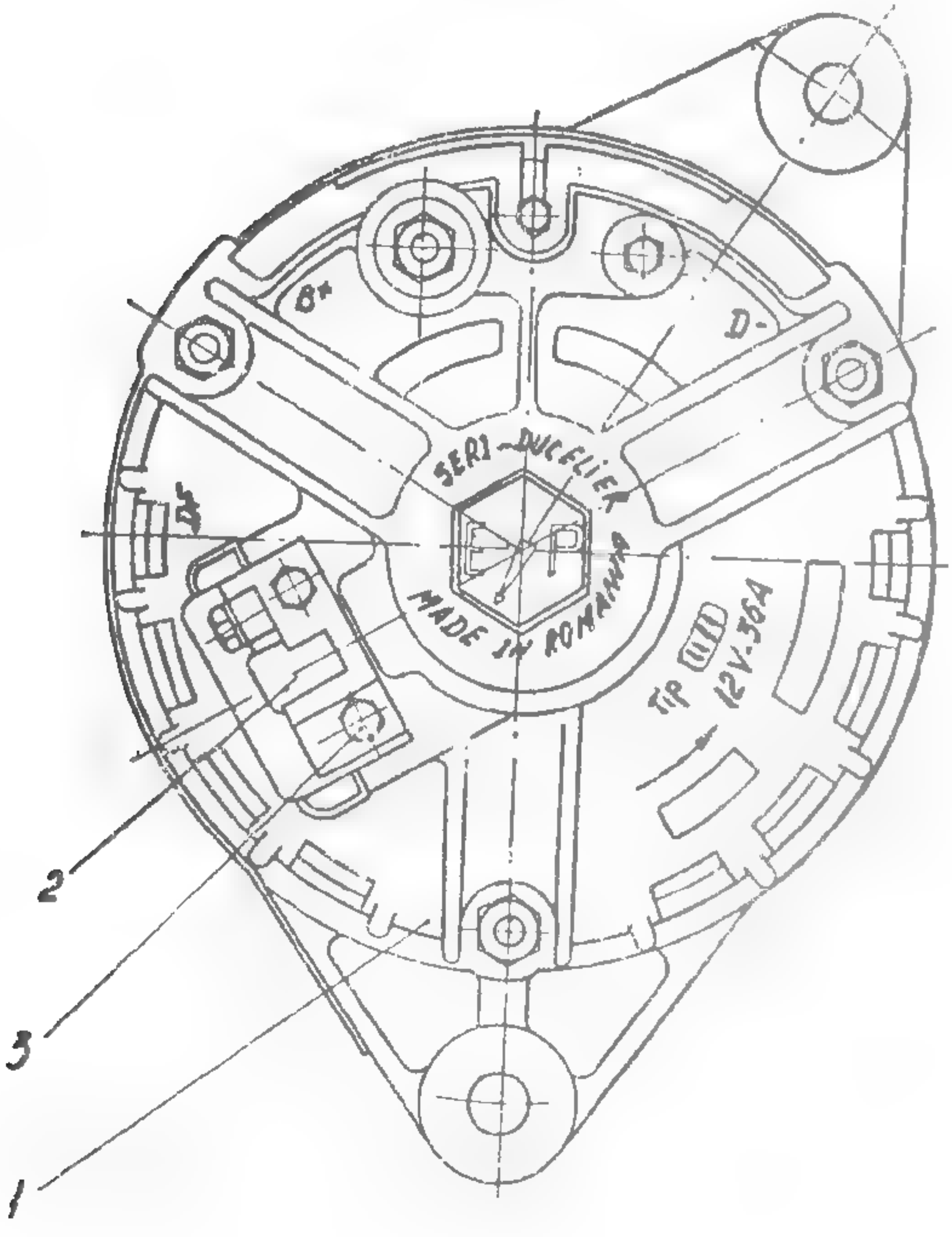


Fig. 4.26. FRONT VIEW OF ALTERNATOR.
1. Slip ring endshield; 2. Brush-holder block; 3. Screws securing bursh-holder block on endshield

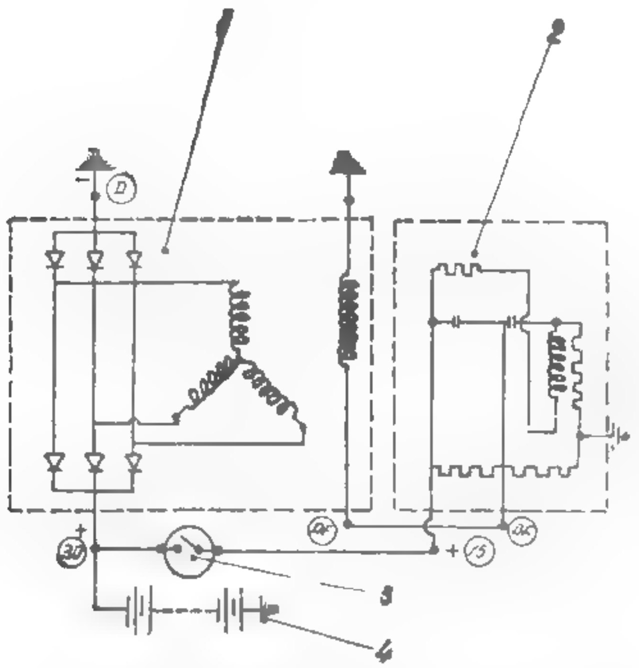


Fig. 4.27. GENERAL CIRCUIT DIAGRAM FOR ALTERNATOR-REGULATOR-STORAGE BATTERY SYSTEM
1. Alternator; 2. Voltage regulator; 3. Ignition lock; 4. Storage battery.

Contact switching between the storage battery and voltage regulator is secured by the means of the switch key (3). The general voltage of alternator is controlled by magnetizing current variation, conditioned by two-step voltage regulator.

Unlike d.c. generator, the three--phase alternator does not need a cut-out relay, to be protected against reverse currents, this protection being secured by the rectifying diodes, included in alternator. At the same time the alternator does not need an overcurrent relay, because the delivered current is self-limited by the alternator itself (see the graph of fig. 4.28).

4.1.6.2. TROUBLES OF ENGINE ELECTRIC EQUIPMENT

The troubles of ignition system have repercussions on engine operation. Intermittent engine running can result also from oxidized cables, leading to

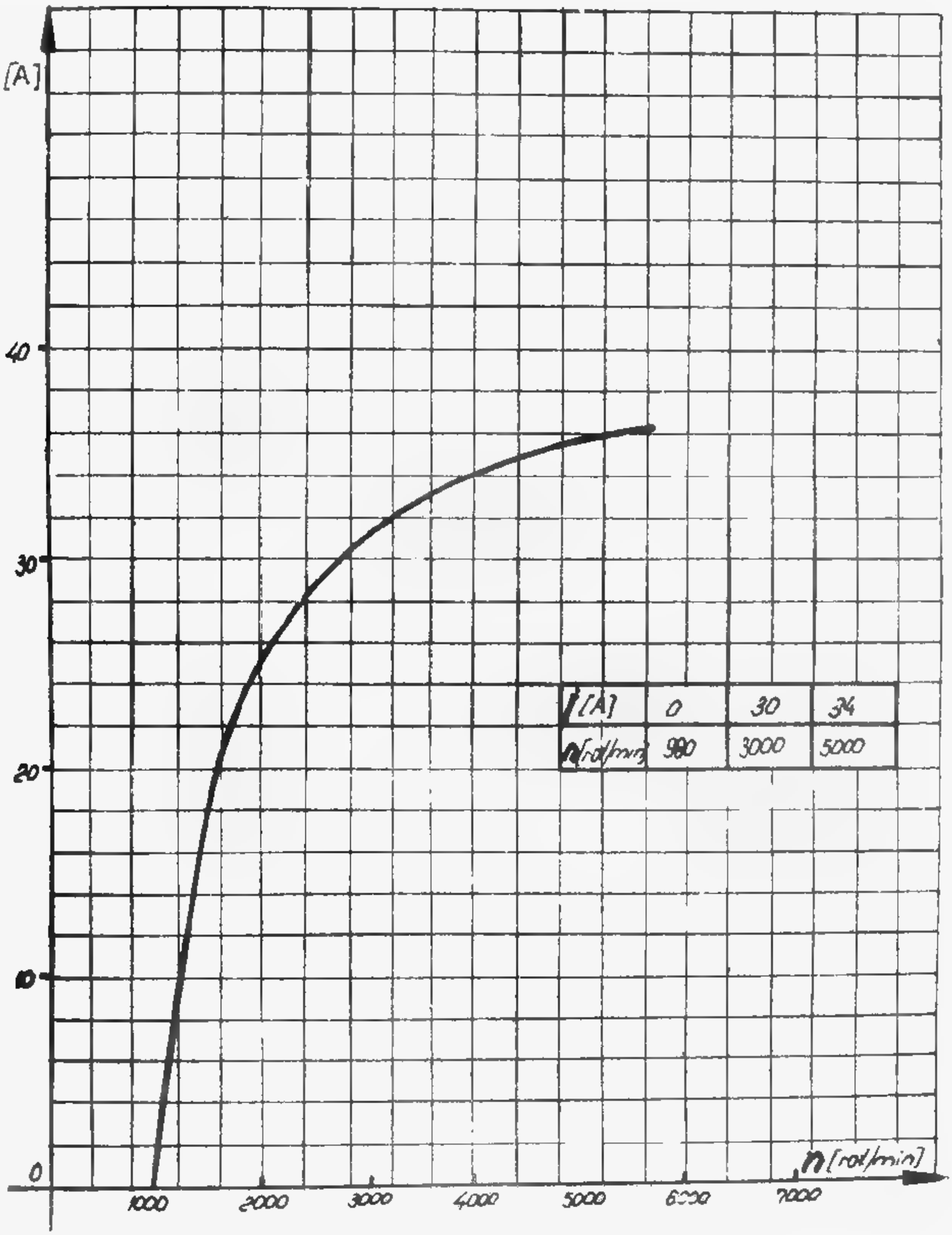


Fig. 4.28. CHARGING DIAGRAM OF 1111-TYPE ALTERNATOR
- Charging current = f (n) r.p.m.

ignition distributor (see also Op. 2. 1. 01. 23. 0), from current leakages, due to faulty distributor cover (fissures) (see also Op. 2. 0. 01. 24. 0) or from faulty distributor rotor (see Op. 2. 0. 01. 25. 0).

The combustion process quality can be judged by the spark plug aspect (see Op. 2. 1. 01. 31. 0).

The checking of electric equipment quality can be performed by the spark estimating, between H. T. ignition cable and the ground (vehicle body) - (see also Op. 2. 0. 36. 01. 0). - If it will be necessary, it should be checked the whole electric supply of engine (see also Op. 2. 0. 37. 15. 0).

- Check and eventually replace ignition distributor condenser (see Op. 2. 0. 37. 16. 0) or ignition coil condenser (see Op. 4. 1. 37. 18. 0), after having previously taken both of them down (Op. 2. 0. 37. 17. 0). If vaccum controlled advance is faulty, the vacuum control unit should be replaced (Op. 4. 0. 36. 03. 1), after having previously taken ignition distributor down from engine (Op. 2. 0. 26. 03. 0).

The engine cannot be started with starting motor, due to oxidized or slacken connection on starting relay (see Op. 2. 03. 7. 08. 0), or disconnected or broken electrical circuit (see Op. 2. 0. 37. 10. 0).

The same trouble can occur if engine ground connection is faulty (see Op. 2. 0. 37. 09. 0).

If starting relay is faulty, (interrupted), it should be changed (see Op. 2. 0. 37. 14. 0).

The starting motor checking, in order to discover its inner troubles, can be performed when it is fitted on vehicle (see Op. 2. 0. 36. 04. 0) or separately (Op. 4. 1. 37. 13. 0), after having taken it down from engine (Op. 2. 0. 37. 12. 0).

- For electrical troubles check, it for interrupted windings (Op. 4. 1. 37. 13. 2), or for ground leakages of its circuits (see Op. 4. 1. 37. 13. 3).
- For mechanical overhauling the motor should be completely dismantled (Op. 4. 1. 37. 13. 4)

If only the Bendix drive is faulty, only this one should be taken down from motor (Op 4. 1. 37. 13. 1).

For checking alternator check firstly the dashboard instruments indications, and then the battery condition. If alternator does not charge the battery or charges it insufficiently, proceed as indicated in Op. 2. 0. 36. 05. 0 and 2. 0. 36. 06. 0.

On the contrary, if it charges battery too much and the latter shows "effervescence", perform remedying as described in Op. 2. 0. 36. 07. 0.

If remedying in this way cannot be obtained, take alternator down from engine (Op. 2. 0. 37. 19. 0) and perform following checkings:

- Check alternator diodes (Op. 4. 1. 37. 19. 1).
- Check wound rotor assembly (Op. 4. 1. 37. 19. 2).
- Check, on a bench, the couple alternator-voltage regulator (see Op. 4. 1. 37. 19. : checking on this occasion alternator load characteristic.
- If alternator pulley is gilty for trouble, replace it, acc. to Op. 4. 1. 37. 19. 4.

■. 1. 6. 3. CHECKING REMEDYING OPERATIONS FOR ELECTRIC ENGINE COMPONENTS

OP. 2. 1. 01. 23. 0 CLEANING DISTRIBUTOR BREAKER POINTS

- Disconnect H. T. ignition cables from distributor cover.
- Remove distributor cover.
- Remove fixed contact plate and adjust fixed contact (point) by means of a fine watchmaker's file, removing oxidized metal, giving to the contact a shape of spherical cap, symmetrical to its axis (see fig. 4. 29).

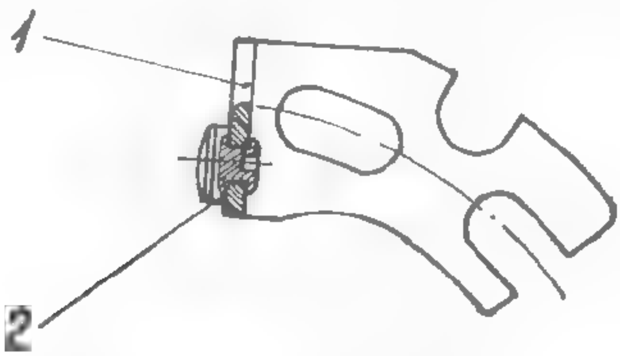


Fig. 4. 29. FIXED CONTACT PLATE (ASSY)
1. Fixed contact plate; 2. Fixed contact.

- Remove then breaker arm and perform the same adjusting as by fixed contact (see fig. 4.30).

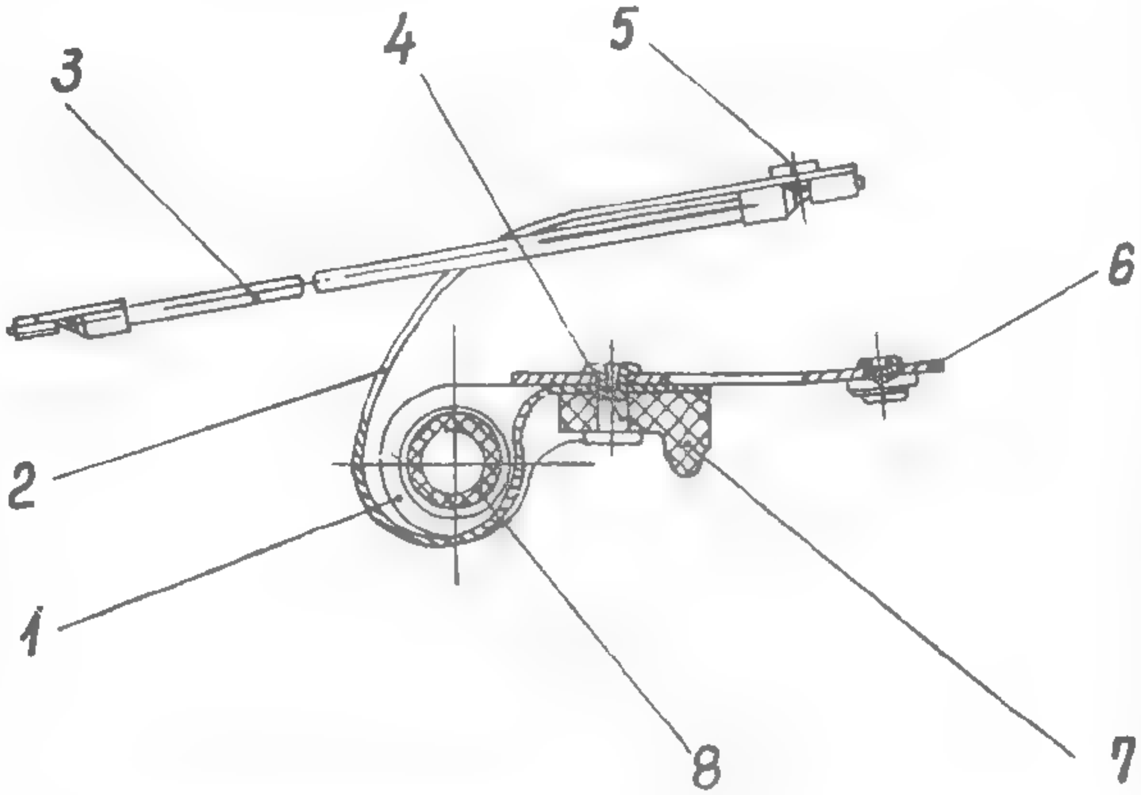


Fig. 4.30. BREAKER ARM (ASSY)
1. Breaker arm; 2. Breaker arm spring; 3. Connecting lead; 4. Fastening rivet; 5. Rivet; 6. Breaker contact; 7. Breaker arm insulated heel; 8. Insulating bush.

- Blast adjusted contacts with compressed air to remove metallic powder.
- Refit components in reverse order. Before fitting the cover, adjust breaker points gap, acc. to Op. 2.0.01.09.0.

OP. 2.0.01.24.0 CHECKING & CLEANING IGNITION DISTRIBUTOR COVER

Remove H.T. ignition cables from distributor cover.

- Remove ignition distributor cover and wipe it with a clean, dry cloth.

- Blast it with compressed air.
- If there will remain uncleaned areas, due to oil drops, impregnate the cloth with gasoline or white-spirit and wipe cover clean and dry.
- Check carefully if there are no fissures in the cover mass.
  Fissured covers should be replaced with new, good covers.
- Refit cover on distributor and reconnect H.T. ignition cables.

OP. 2.0.01.25.0 CHECKING, EVENTUALLY CHANGING IGNITION DISTRIBUTOR ROTOR

- Remove H.T. ignition cables from distributor cover.
- Remove distributor cover.
- Remove distributor rotor from its shaft and wipe it dry.
- Check if there are no fissures or indentations.
  Faulty parts should be replaced with new, good ones.
- Refit all components in reverse order.

OP. 2.1.01.31.0 CHECKING SPARK PLUGS. APPRECIATION OF CARBURATION EVENTUALLY SPARK PLUG REPLACEMENT

The spark plug condition indicates how operates the engine.
If the spark plug central electrode has a brown-reddish, while the ground electrodes are grey, and on the frontal face of metallic spark plug body is deposited a black film, it means that the engine is in a good operating condition and the spark plug is adequate.
When on spark plug surface is a carbon deposit, one can conclude the followings:

- The spark plug has a too low heat range.
- The fuel/air mixture is too rich (decalibrated carburettor jets, too high fuel level in carburettor float chamber).

aults in the ignition system (ignition coil, ignition distributor, faulty condensers).

- Ignition lag, due to distributor detuning.
- Unadequate gasoline.

If plag centre, ground electrodes and plug metallic body are covered with an oily carbon deposit, it means that the spark plug has a low heat range, or that the engine has following troubles (more frequent case): worn out cylinder, broken or worn out scraper rings, worn out valve seats, clogged muffle rear pipe, too high oil level in the oil sump.

If spark plug centre electrode has a grey-brown colour, with deposit on its surface and the ground electrodes are burnt, it means that the spark plug has a too high heat range, or that the engine has following troubles: unadequate carburettor adjusting (fuel/air ignition advance).

The spurk plugs should be fitted be screwing, using a torque of max. 5 daNm (kgm). (36.8 ft.lbs).

The remedyings of mentionned troubles are explained in the paragraphs concerning carburation and ignition system.

In case that a spark plug has faults, as burnt electrodes, fissured insulation, etc. it should be replaced by a new spark plug, having adequate heat range.

OP. 2.0.36.02.0. CHECKING ENGINE ELECTRIC EQUIPMENT BY THE SPARK OBSERVED BETWEEN DISTRIBUTOR CENTRE PLUG AND DISTRIBUTOR IGNITION CABLES AND THE GROUND

- Remove H.T. centre cable from ignition distributor and bring it near the engine block, at a distance of 6-7 mm, holding it on its insulation.
- Switch the starting key and let the engine to crank 2-3 turns, observing in the same time the spark between the H.T. cable and engine block. The spark should be of the same intensity for all four cylinders.

- For checking spark plug ignition cables, remove them successively from each spark plug, remove each time the nsulating end piece and proceed similarly as with the centre ignition cable, on each checking the engine can be started, operating only with three cylinders.
- In case that the spark on H T centre ignition cable is not correct, check ignition coil, ignition distributor and their condensers.
- If the spark on spark plug ignition cable is not correct, shoot the trouble in the same circuit as for centre cable Check also H. T. cables condition.

OP. 2. 0. 36. 03. 0 REMEDYING THE IGNITION DISTRIBUTOR. TAKING IT DOWN FROM ENGINE

In case that ignition distributor troub es do not confine themselves on breaker points, ignition distributor cover or rotor, whose remedying was indicated before, it is necessary to take ignition distributor down from engine in order to remove its faulty component.
For this:

- Remove ignition distributor cover, together with ignition wires.
- Disconnect distributor from vacuum connecting tube.
- Remove the clamp fastening distributor on engine block.
- Draw out distributor from the engine block, by a slight rotation, in order to allow its disangaging from camshaft gear.
- On refitting, perform all operations in reverse order.
  Finaly, before fasten distributor definitively, adjust ignition according to Op 2. 0. 01. 13. 0.

OP. 4. 0. 36. 03. 1 REPLACING VACUUM CONTROL UNIT OF DISTRIBUTOR

- Take ignition distributor down from engine, acc. to Op. 2. 0. 36. 03. 0.
- Unscrew bolts fastening vacuum control unit on ignition distributor (the clamp and condenser).
- Remove the lock and, depressing slightly the vacuum control unit spring, remove excentric together with the rod and vacuum control unit.

B-f re replacing the vacuum control unit, check the spring, which, compressed up to 25 mm length schould have 16.5 $\pm$ 7% N (1.65 kg) force. If the spring is decalibrated, replace it with an original one. If the vacuum control unit is not hermètic, replace it with an original one.

- Refitt all components in reverse order.

OP. 2 0.36.04.0 STARTER LOAD AND NO LOAD TEST, WITHOUT TAKING STARTER DOWN FROM ENGINE.

To shoot starter troubles, you can performe necessary tests with the starter taken down from engine or without take it down.

OP. 2.0.36.04.1 STARTER LOAD TEST WITHOUT TAKE IT DOWN FRON ENGINE

[illegible]nect to battery terminals a voltmeter and read voltage drop just as mo[illegible] starts. In order to have more time (about 5 seconds) when reading the voltage drop, take off the central ignition lead from ignition distributor and [illegible] sparks to ground (vehicle body). (For this test the engine should be warm).

Do connecting diagram, according to Fig. 4.31. :

For this·

[illegible]nnect an ammeter, of about 300 A, to starter relay input terminal.

[illegible] ammeter in series with a variable resistor of about 300 W/12 V - [illegible] commutator being ground connected.

[illegible] performing connections, put variable resistor at its maximal resistance or interrupt it.

[illegible] resistor sliding contact, increasing the amperage, till the voltmeter [illegible] indicate the same voltage drop which was read formerly by motor starting. At that moment through the ammeter should pass a current of max. 190 A

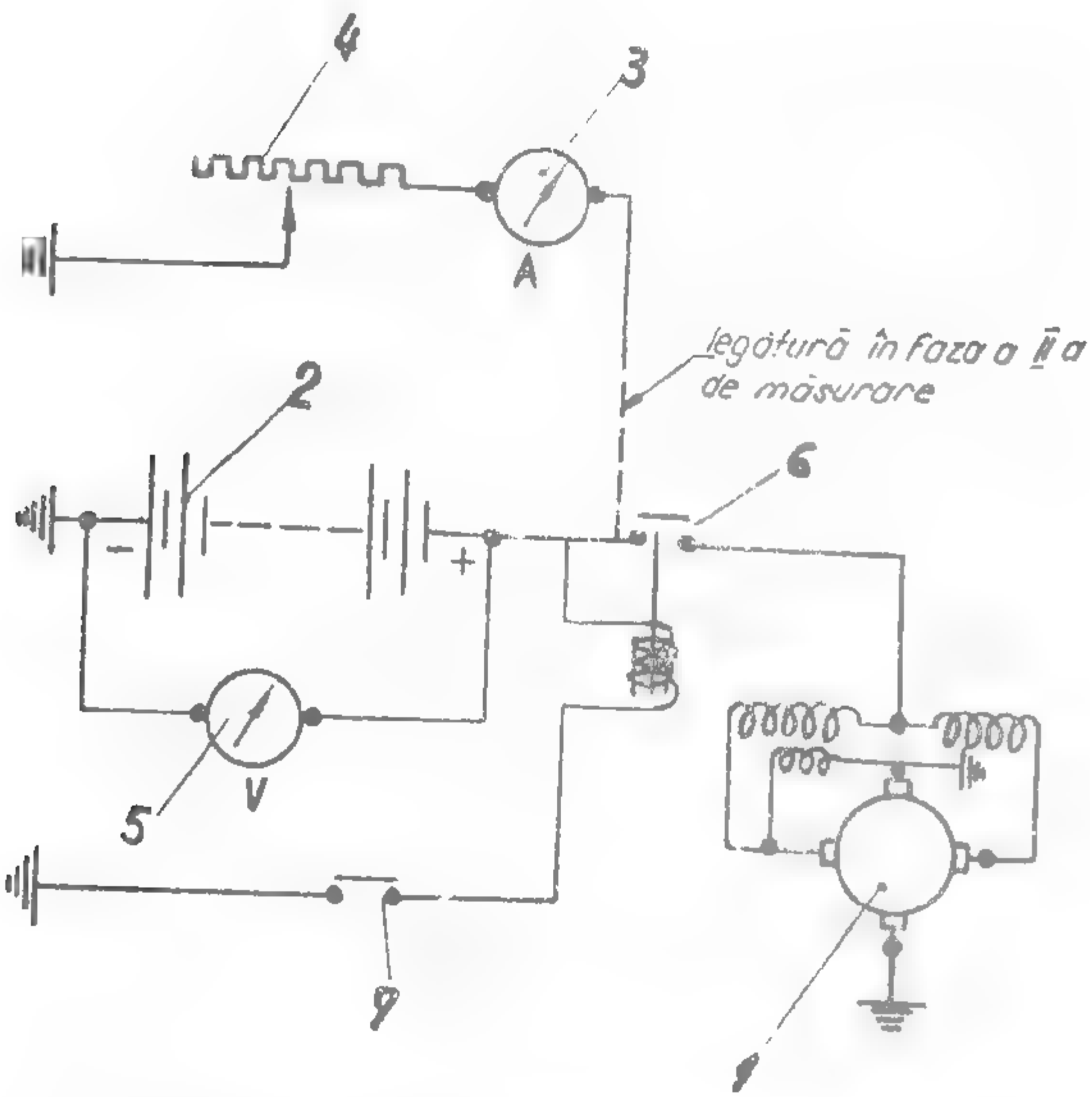


Fig. 4. 31. CONNECTION DIAGRAM FOR STARTING MOTOR LOAD TEST.
1. Starting motor; 2. Storage battery; 3. Ammeter (300 A); 4. Variable resistance (3000 W/12 V); 5. Voltmeter; 6. Starter relay; 7. Ignition switch.

- In case that the ammeter indicates a greater current value, it means that the starter motor is faulty or that there are excessive frictions in the engine, wha will be proved doing the next test ("no load test").

OP. 2. 0. 36. 04. 2 STARTER NO LOAD TEST

For this test the motor should turn at a low speed (to avoid the meshing of its drive pinion with engine flywheel ring gear).

shorten starting relay terminals with an ammeter of about 300 Amp., connected in series with a safety resistance of 3000 W/12 V (see connecting diagram in the Fig. 4.32.).

- Start the motor, diminishing gradually safety resistance value.

The ammeter indication should not exceed 90 Amp. If the motor current exceeds the above mentioned value, it means that there are winding breaks or short-circuits, armature frictions, shaft bending.

No load test can be also performed after taking starting motor down from the engine, on a test bench.

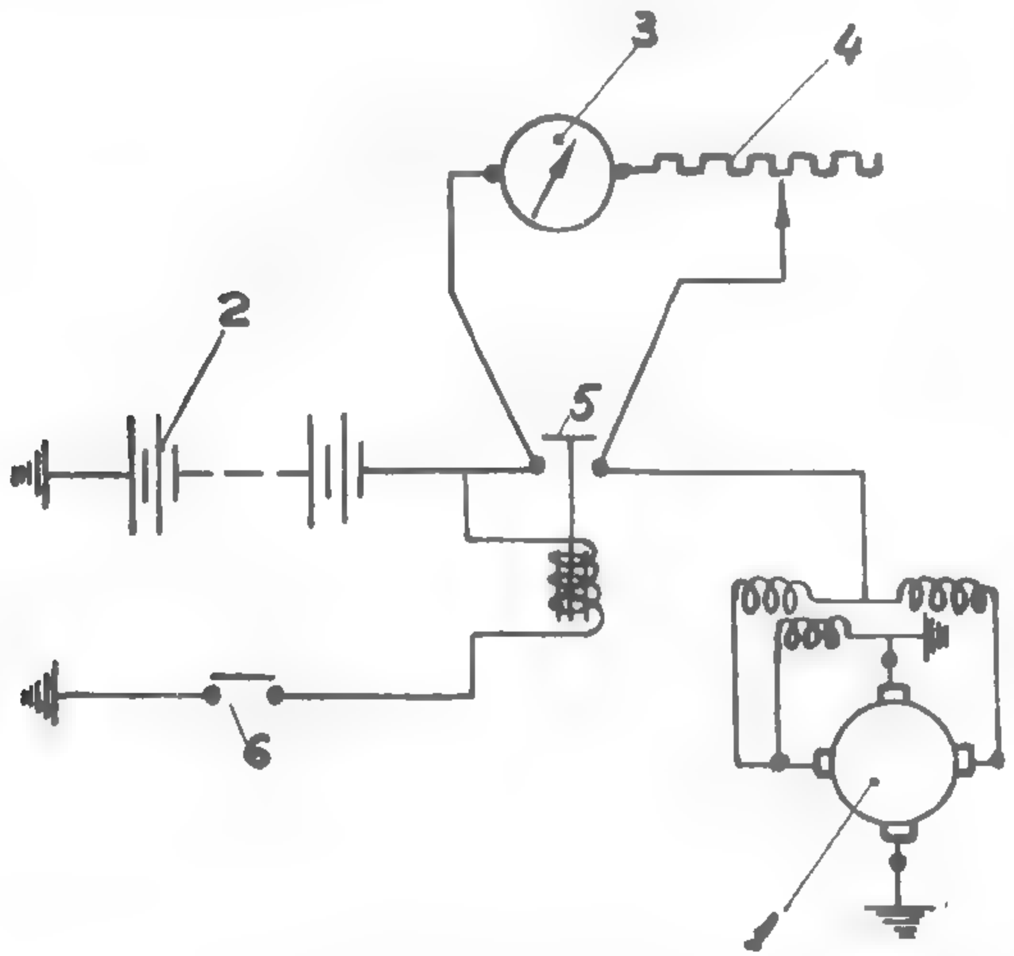


Fig. 4.32. CONNECTION DIAGRAM FOR STARTING MOTOR NO-LOAD TEST
1. Starting motor; 2. Storage battery; 3. Ammeter (300 A); 4. Variable resistance (3000 W/12 V); 5. Starting relay; 6. Ignition switch.

OP. 2.0.36.06.0 CHECKING & REMEDYING ALTERNATOR WHEN IT DOES NOT CHARGE

- Check firstly V-belt correct tension.
- Check if there is no great circuit resistance, due to slacken terminals, broken or partially rubbed out leads.
- Check field energizing circuit for breaking. In case that a resistance measuring bridge (Wheatstone bridge) is available, check the resistance between alternator "DF" terminal and the ground (vehicle body). The correct resistance should be comprised between 4.6 and 5.5 Ohms. During this measuring rotate slightlythe alternator rotor, in order to check contact continuity between the brushes and slip rings.
- If measured resistance is under 4.6 Ohms, it is possible that rotor windings have short-circuits. If it is above 5.5 Ohms, it is possible that rotor winding is interrupted or solded connection between rotor winding and slip rings is faulty.
- Check brush pressure upon the slip rings, by measuring the pressure of brush springs, which should be 0.200 ... 0.250 daN (kg), for new brushes, in operating position.
- If the trouble causes could not be found, check rectifying diodes and rotor winding.

OP. 2.0.36.05.0 ALTERNATOR DOES NOT CHARGE. CKECKING REMEDYING

- Check if the charging or field energizing circuits are not brocken.
- To do that, check alternator terminals and terminal connections, voltage regulator terminals, the starter relay "30" terminal, the first three of the fuse box left underside, the "30" and "15" terminals of the switch key, as well as the ground connections (see Fig. 4.33).

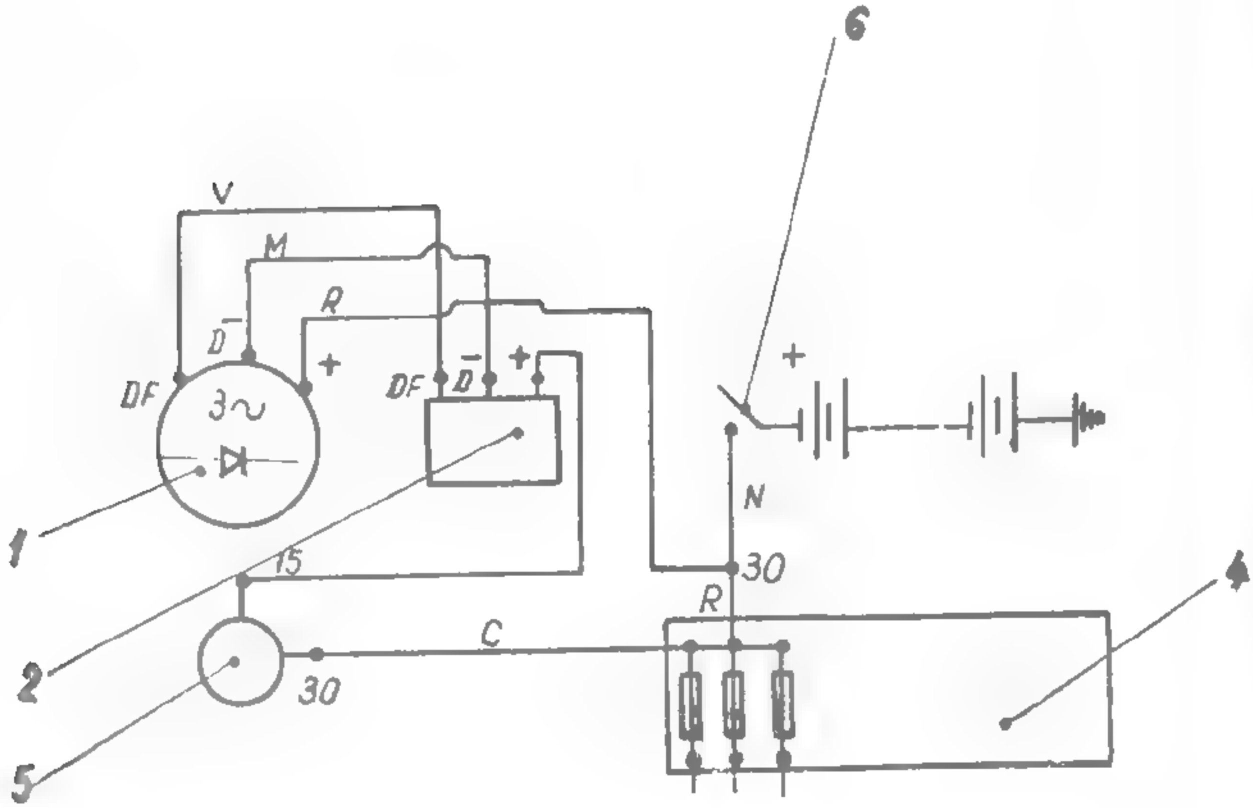


Fig. 4.33. CONNECTION DIAGRAM FOR INSTALLING 1111-TYPE ALTERNATOR ON ARO VEHICLES.
1. Alternator (three-phase); 2. Voltage regulator; 3. Storage battery; 4. Fuse box; 5. Ignition switch; 6. Battery master switch

- When the vehicle is equipped with a battery out-out main switch, it should be also checked.
- If no fault has been found at above mentioned connections, check by means of a test lamp of max. 25 W/12 V (for instance the lead lamp from vehicle tool outfit) alternator energizing circuit, as follows:
- Connect again storage battery.
- Touch one terminal of the test lamp with voltage regulator " + " terminal and the other terminal of the test lamp touch with the ground (vehicle body), as shown in the Fig. 4.34: the test lamp should light by switching on the ignition switch key.
- If test lamp does not light, check fault in the following circuits:
  - Fuse box - ignition switch "30" terminal.

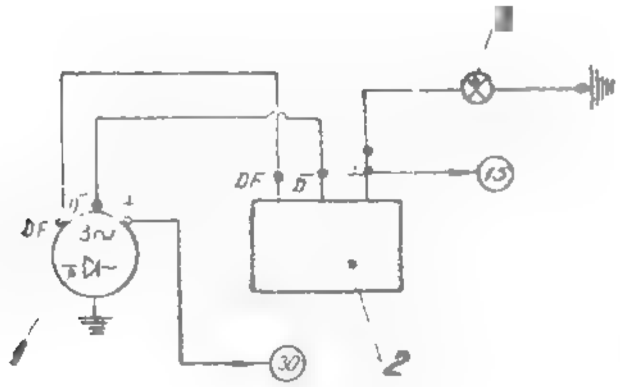


Fig. 4.34. DIAGRAM FOR TESTING CONNECTING CIRCUIT BETWEEN BATTERY, IGNITION SWITCH AND VOLTAGE REGULATOR.
1. Alternator; 2. Voltage regulator; 3. Test lamp; (15) and (30): connecting leads to ignition switch respective terminals.

- Ignition switch "15" terminal - voltage regulator " + " terminal.
- If alternator does not charge, although there is voltage at regulator " + " terminal, stop the engine, disconnect alternator "DF" contact plug and to connection between AMP-type contact plug (green lead wire) and alternator "DF" terminal, through the test lamp (see Fig. 4.35.).

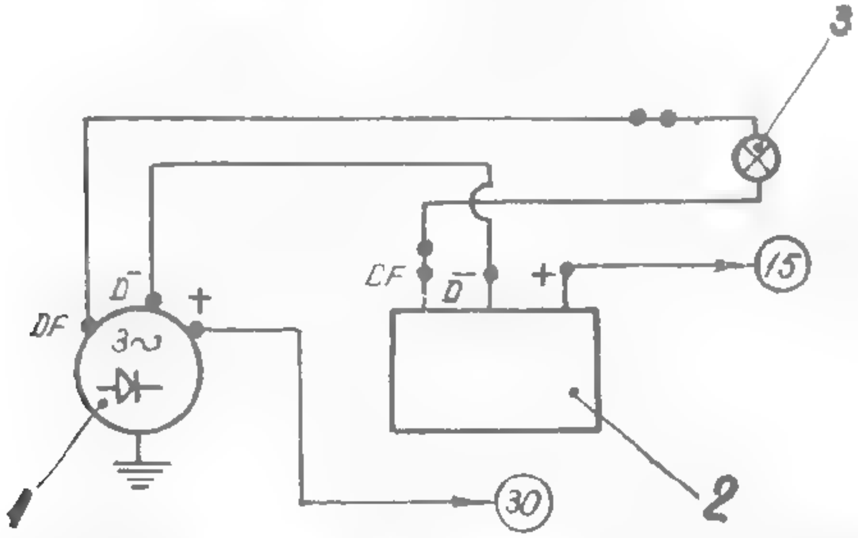


Fig. 4.35. CONNECTION DIAGRAM FOR CHECKING EXCITATION CIRCUIT OF ALTERNATOR
1. Alternator; 2. Voltage regulator; 3. Test lamp; (15) and (30). connecting leads to respective terminals of ignition switch.

- By closing the circuit with the switch key, the test lamp should light; if not, connect test lamp between green lead contact plug and the ground (see Fig. 4.36.).

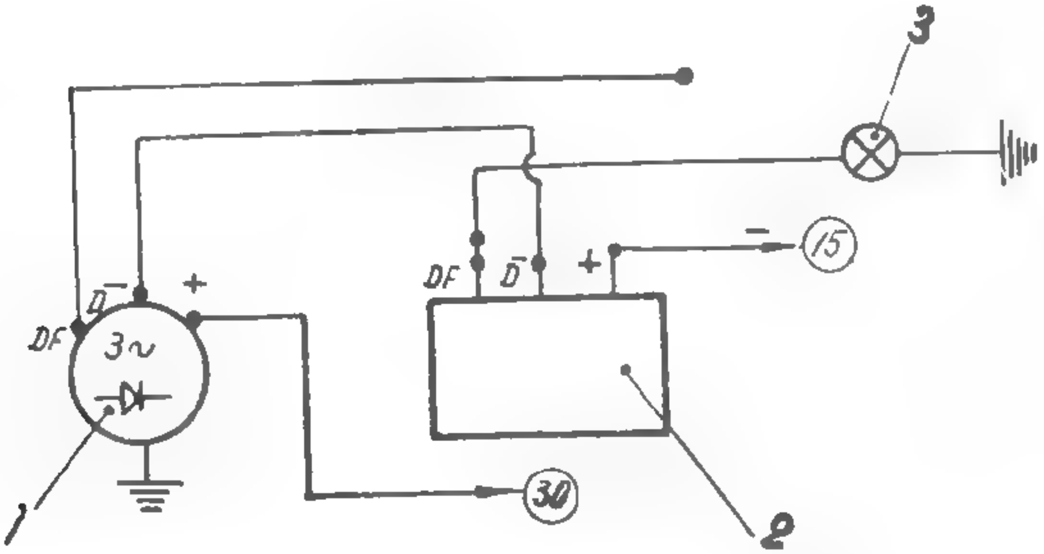


Fig. 4.36. CONNECTION DIAGRAM FOR CHECKING EXCITATION CIRCUIT OF VOLTAGE REGULATOR.
1. Alternator; 2. Voltage regulator; 3. Test lamp; (15) and (30): connecting leads to ignition switch respective terminals.

- If this time the test lamp does light (by closed circuit through the switch key), the trouble should be sought in the alternator field energising circuit; if the test lamp does not light, the voltage regulator is faulty.
- To check the alternator field energising circuit, remove the alternator "DF" terminal plug and unscrew the two screws (3) - see Fig. 4.37, which fasten the brush holder assembly (2) on slip ring end shield.
- Draw out brush holder assembly and check brush length (min. 6 mm).
- Check also if the brushes slide smoothly in their brush-holders.

If with the above mentioned methodes the trouble causes could not be found, take down alternator from the vehicle and check rectifying diodes and rotor winding.

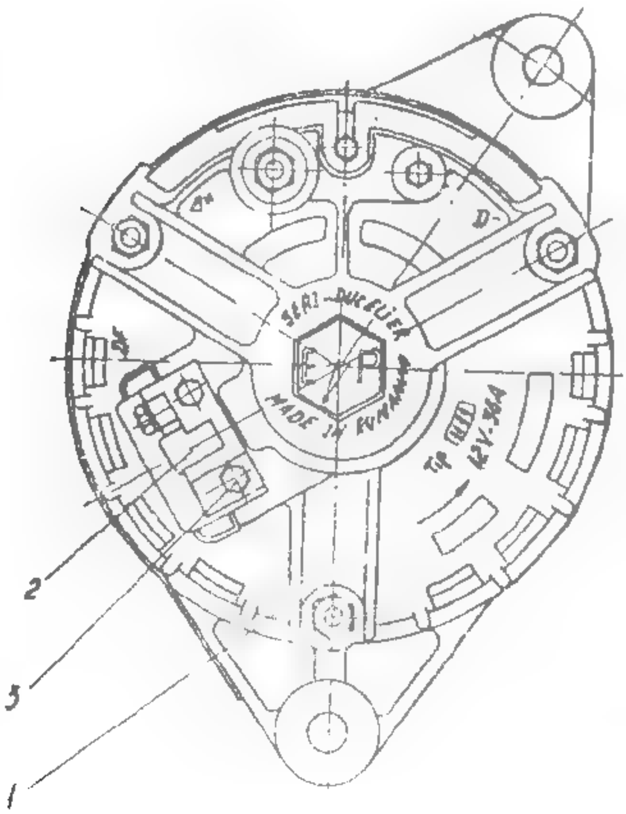


Fig. 4.37. FRONT VIEW OF ALTERNATOR (common with Fig. 4.26).
1. Slip ring end shield; 2. Brush-holder block; 3. Screws securing brush-holder block on endshield.

OP. 2.0.36.07.0 CHECKING AND REMEDYING WHEN ALTERNATOR CHARGES TOO MUCH (BATTERY IS GASSING)

The trouble should be sought in voltage regulator or in its circuit. Check firstly if connections are correct, according to connecting diagram (see Fig. 4.33).

- Check if voltage, controlled by voltage regulator, does not exceed 14.7 ... 15 V (between " D " and " + " terminals).
- Check rotor winding resistance, to see if there are no short-circuits in windings.
- If this checking is not conclusive, a bench test should be done.

OP. 4.1.37.13.0. REMEDYING STARTER MOTOR TAKEN FROM ENGINE

Starter dismounting

The accumulators battery is disconnected.

The electrical connexions of the starter are disconnected.

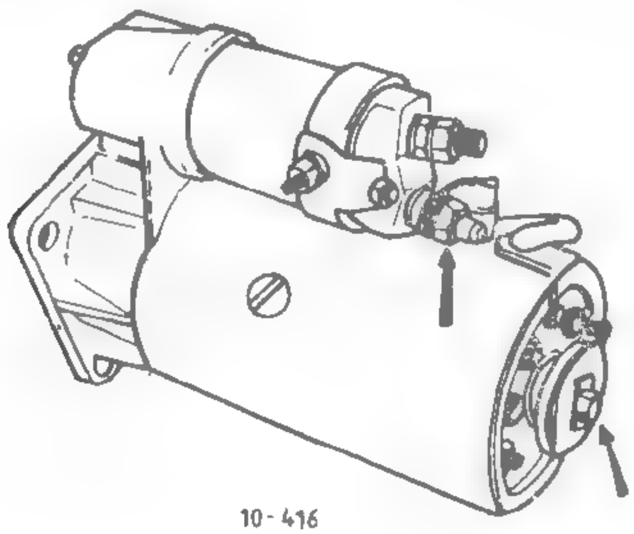
The starter is disconnected unscrewing the screws filting on the clutch car-case.

Remounting is made in the reverse order of the dismounting.

- The stator dismounting

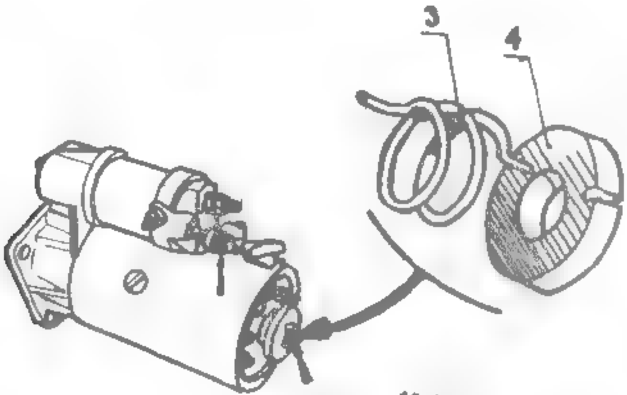
You must dismount:

- the rear protecting cover;
- the screw from the rotor end (10-416) is unsecured and it is dismounted;



10-416

- the rear bearing after that the stator brush is extracted from its place (10-419).



10-419

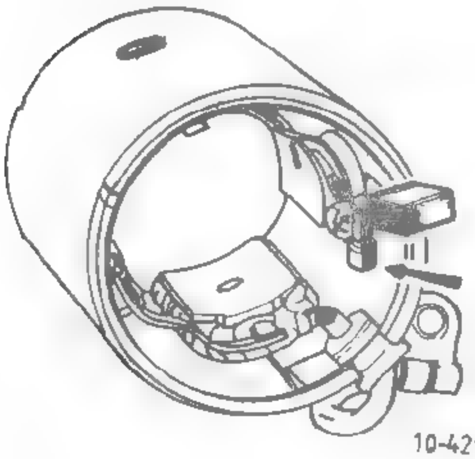
The terminal is extracted from the starting relay.

The stator is extracted.

The collector and brushes statement is checked.

If the collector has not the wearing marks or pinches it is cleaned by a non-ignitable solvent and by a fine abrassive paper.

If their brushes and springs are weared they must be replaced (10-422) (10-421).



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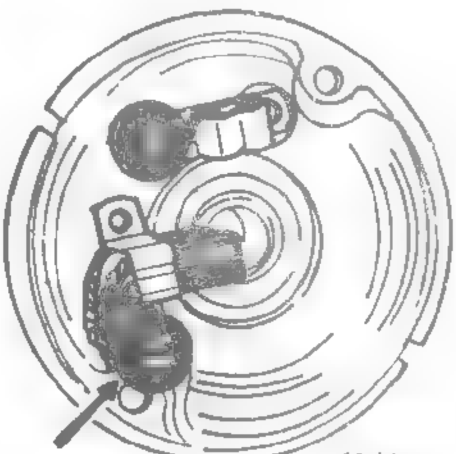


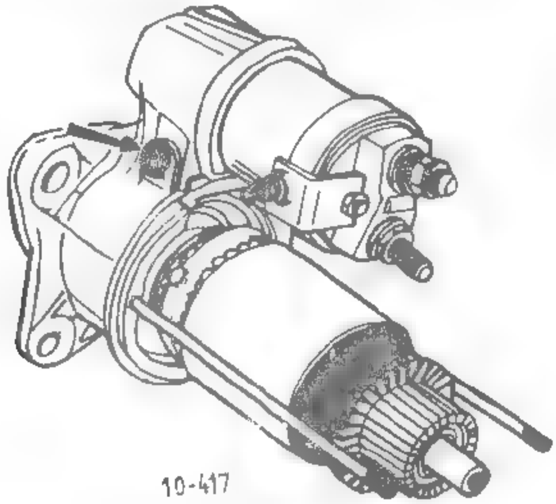
10-422

Its remounting is made in a reverse order of its dismounting.

- Replacement of the coupling mechanism

The stator is dismounted according to the anterior paragraph.

The axle of the coupling mechanism fork is extracted (10-417).

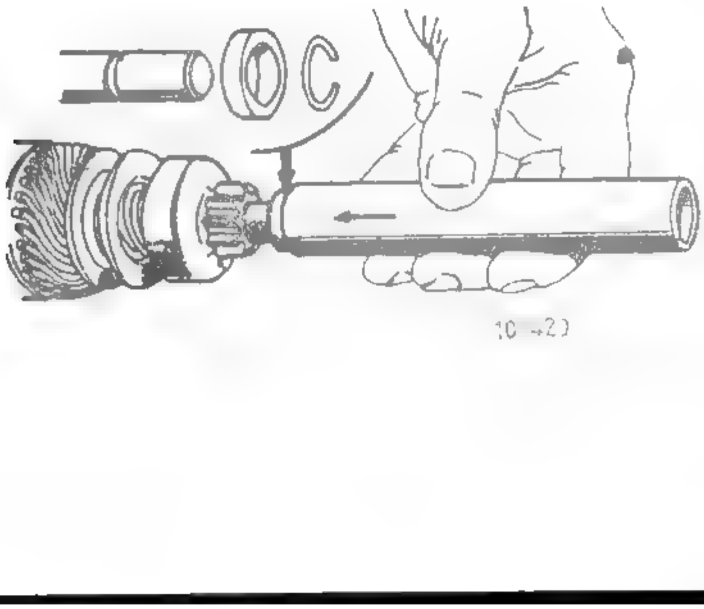


10-417

The four screws fitting the solenoid on the carcass are unscrewed.

The rotor and the solenoid are extracted.

The bearing is extracted by means of the pipe to permit the releasing of the holding ring (10-420).

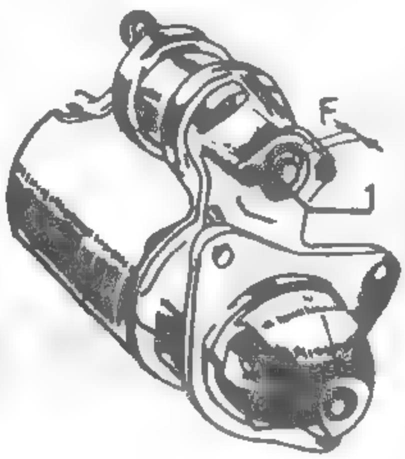


10-420

If it is necessary the assembly "pinion-bearing" is replaced.

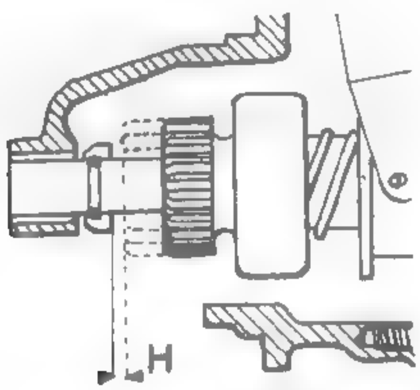
If it was necessary the replacement of the coupling mechanism or of the solenoid you must adjust the connecting fork position as follows:

- the play (F) between the screw and the adjusting position must be as smaller as possible (10-424).



10-424

- in this position the coupling mechanism must be as support on the stator;
- the screw of the starting relay is pressed and the play (H) must be from 0,05 to 1,5 mm (10-425).



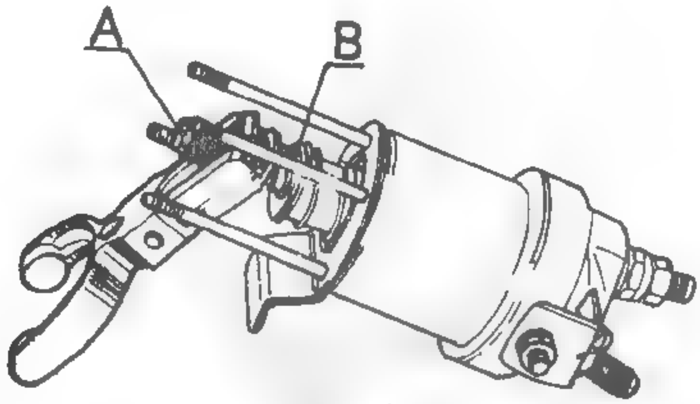
10-425

- you must operate to the adjusting nut to obtain the necessary plays F and H.

- The solenoid replacement

The solenoid is dismounted according to the paragraph 3.9.4.

The screw A is unblocked pressing to the ronde B(10-423).



10-423

The connecting fork is replaced.

After its remounting make the adjustments according to the paragraph 3.9.4.

OP. 2.0.36.01.0 CHECKING SPARK PLUG END FOR COMBUSTION JUDGEMENT (see Op. 2.1.01.31.0)

OP. 4.1.37.19.1 CHECKING ALTERNATOR DIODES

- Take alternator down from engine, acc. to. Op. 2.0.37.06.1 and put it on a workshop bench. The characteristics of the 6 silicon diodes, fitted on the 1111 type alternator, are:

- Max. direct current .... 25 A
- Max continuous inverse voltage .... 75 V
- Max. peak inverse voltage .... 200 V
- Max. operating temperature .... 150^{0}C

The diodes are semi-conductors which allow the current to pass in a single sense; they can have either of the following two faults:

- They do not let the electric current pass in either sense; in this case they are interrupted.
- They allow the current to pass in both senses, in which case they are short-circuited.
- To check the diodes remove plastic protecting cover, unscrewing the bolt placed between "D" and "B" terminals.
- Unscrew the 3 nuts (1), for diodes connecting, placed under tne cover and make free the leads (2) of stator winding (see Fig. 4.41).

CHECKING POSITIVE DIODES TOWARDS ALTERNATOR TERMINALS

Use for checking diodes a 5 ... 25 W/12 V test lamp and a 12 V storage battery.

a) Connect negative terminal of the battery to the "B +" alternator terminal and the free terminal of the test lamp, in turn to the three terminals of the diode-holder assembly (see fig. 4.42).

NOTE: Positive diodes are marked with a red letter and negative diodes, with a black one.

The test lamp must light for each of the 3 diodes. If not, respective diode is interrupted.

b) Make inverse connection, with the free terminal of the test lamp to the "B +" alternator terminal and the negative terminal of battery, in turn to the 3 terminals of the diode-holder assembly.

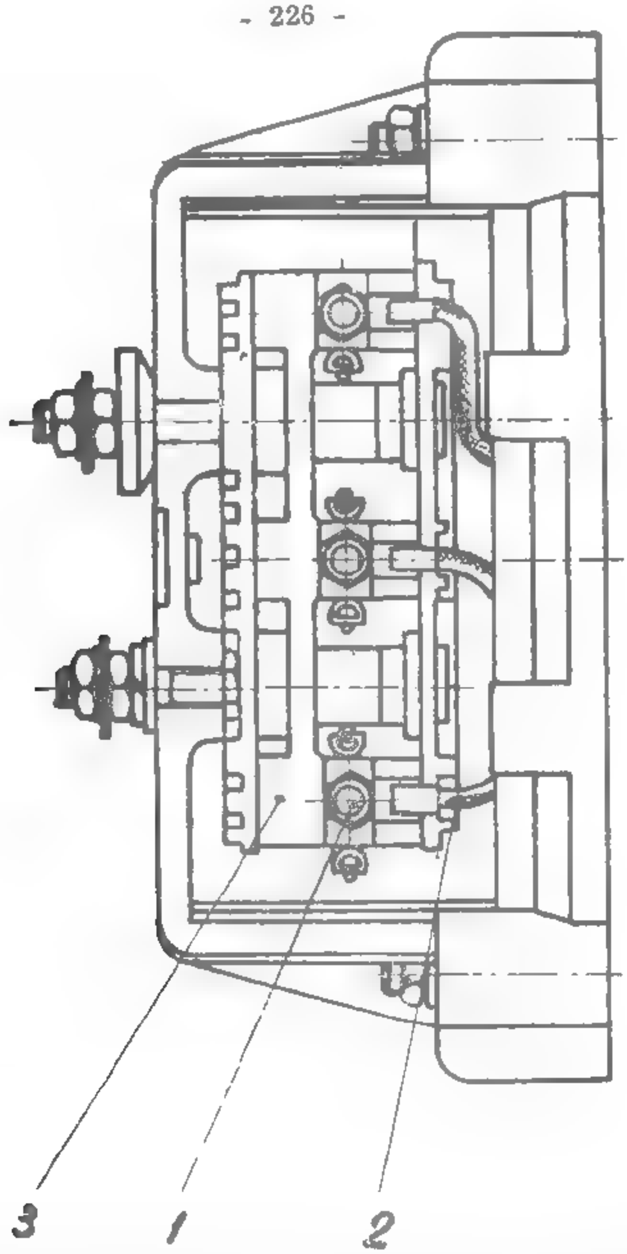


Fig. 4.41. DIODE-HOLDER AND TERMINAL ASSEMBLY.
1. Nut securing field coil terminals to diodes; 2. Field coil terminals; 3. Diode block incorporated in the diode-holder.

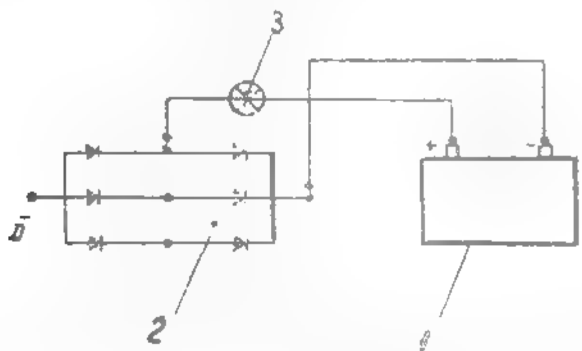


Fig. 4.42. CONNECTION DIAGRAM FOR CHECKING DIODES (TOWARDS THE ALTERNATOR TERMINALS) FOR UNTERRUPTED CIRCUIT.
1. Battery (12 V); 2. Diode block; 3. Test lamp (5W/12V).

If the diodes are good, the test lamp must not light; if it lights the respective diode is short-circuited (see Fig. 4.43).

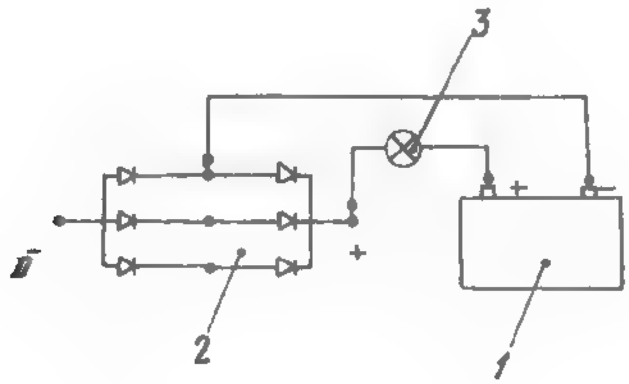


Fig. 4.43. CONNECTION DIAGRAM FOR CHECKING DIODES (TOWARDS THE ALTERNATOR TERMINALS) FOR BREAKDOWN.
1. Battery (12 V); 2. Diode block; 3. Test lamp (5 W/12 V).

CHECKING NEGATIVE DIODES OPPOSITE THE TERMINAL SIDE

c) Connect the free terminal of the test lamp to the "D -" alternator terminal and the negative battery terminal, in turn tot the 3 terminals of the diode-holder assembly. If the diodes are good, the lamp must light; if it does not, the diode is interrupted (see Fig. 4.44).

d) Connect the negative terminal of battery to the "D -" alternator terminal and free terminal of the test lamp, in turn, to the 3 terminals of the diode-holder assembly. If the diodes are good, the test lamp will not light. If it does, the diodes are short-circuited.

A faulty diode cannot be replaced in the aluminium holder, in which it has been pressed-in. In case that a positive diode is faulty, the positive diode-holder assembly (ref. No. 1.110.036.) should be replaced. For a faulty negative diode should be replaced the negative diode-holder assembly (ref. No. 1.110.031).

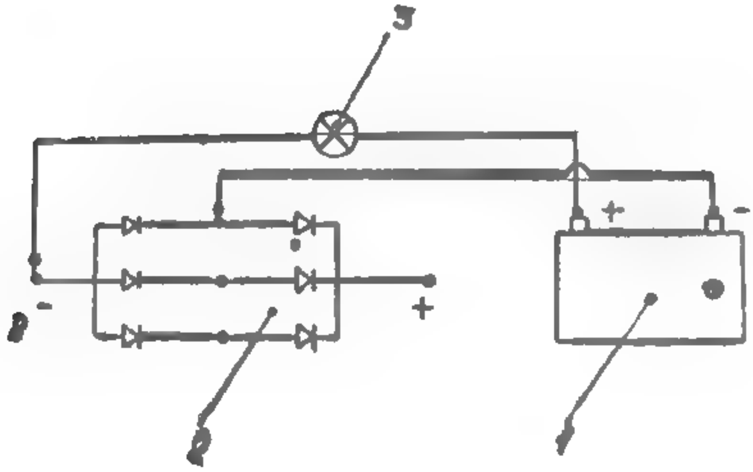


Fig. 4.44. CONNECTION DIAGRAM FOR CHECKING DIODES (OPPOSITE THE ALTERNATOR TERMINALS) FOR INTERRUPTED CIRCUIT.
1. Battery (12 V); 2. Diode block; 3. Test lamp (5 W/12 V).

ATTENTION! Check the diodes only with a test-lamp serially connected to a battery. Never check the diodes with ALTERNATING CURRENT from the mains or with an inductor (megohmmeter), so as not to destroy them!

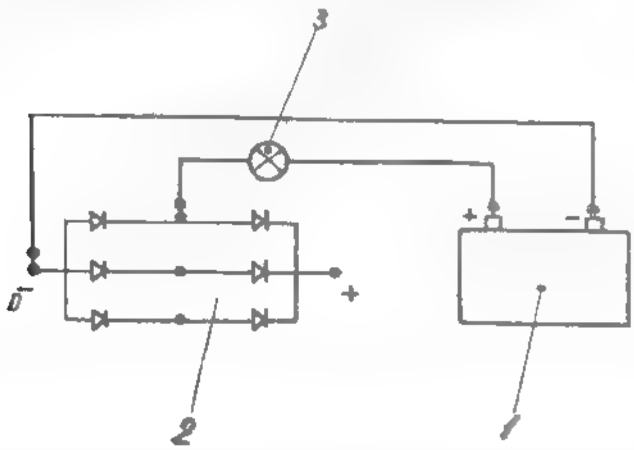


Fig. 4.45. CONNECTION DIAGRAM FOR CHECKING DIODES (OPPOSITE THE ALTERNATOR TERMINALS) FOR BREAKDOWN.
1. Battery (12 V); 2. Diode block; 3. Test lamp (5 W/12 V).

OP. 4. 1. 37. 19. 0 CHECKING ALTERNATOR ROTOR

- Take alternator down from engine, acc, to Op. 2. 0. 37. 06. 1, after having interrupted current in electrical equipment.
- Check rotor circuit acc. to Op. 2. 0. 36. 05. 0. The resistance of the rotor can also be measured by the voltmeter-ammeter method between alternator "DF" terminal and ground (vehicle body).
- If necessary, clean the slip-rings, If they show an excessive wear they may be turned in a lathe.
- Before ffitting the brushes, remove the coal dust by air blasting, or eventually, by washing with petrol or white-spirit and drying by air blasting.

OP. 4. 1. 37. 19. 4 REPLACING ALTERNATOR PULLEY

- Take alternator down from engine, acc. to Op. 2. 0. 37. 06. 1.
- Holding the pulley, unscrew the M 16 nut, fastening pulley on shaft.
- Pull off pulley and fan by means of the D 19 extractor. Remove woodruff key.
- Before fiting a new pulley, wash the rotor shaft and pulley bore with white-spirit. Press the new pulley using a sleeve.
- Tighten nut which fastens the pulley using a torque of 4. 5 m. daN (33 ft. lb).
- Refit alternator on engine in reverse order.

OP. CHECKING, EVENTUALLY REPLACING IGNITION DISTRIBUTOR CONDENSER

The condenser can get faulty by breakdown (short-circuit).

- Check condenser using a test lamp, connected between battery positive terminal and condenser input terminal. If the lamp will light the condenser is partially or totally broken down and should be replaced. When condenser is broken down, the spark given by ignition coil is weak or inexistent.

OP. 4.1.37.1.9.5. DISASSEMBLING THE ALTERNATOR

- Take alternator down fron engine, acc. to Op. 2.0.37.06.1.
- Take alternator pulley down, acc, to Op. 4.1.37.19.4.
- Take diode-holder assy. down, performing it as follows:
- Remove cover shield, by unscrewing the bolts with a 7 mm wrench.
- Unscrew the 3 nuts (1) - see fig. 4.41 - of the diode-holder (3) and remove the 3 terminals (2) of stator winding, also with a 7 mm wrench.
- Using a 10 mm wrench unscrew the nuts of the "B +" terminal (see Fig. 4.37), removing spring washer metal washer and insulating bush
- Using a 9 mm wrench unscrew nuts of "D -" terminal, removing the spring lockwashers and flange sleeve.
- Now, after arranging suitably the stator-winding terminals, pull out the diode-holder assembly.
- Take down end shields, performing as follows:
- By means of a box wrench (10 mm) unscrew the 3 nuts securing slip ring end shield. Remove endshield and rotor.
- To separate endshield from rotor use an extractor, so as to not damage the ball bearing.
- Replace faulty components.
- Perform assembling in reverse order to that of dismantling.
- Check if the brushes tread on the slip rings.

On assembling use the following torques:

- M 16 nut securing pulley on shaft .... 4.5 m.daN (33 ft.lb)
- M 6 nuts securing endshield .... 0.7 m.daN (5.2 ft.lb)
- M 6 nuts of "B +" terminal .... 0.5 m.daN (3.6 ft.lb)
- M 5 nuts of "D -" terminal .... 0.3 m.daN (1.1 ft.lb)

When fitting alternator on vehicle, check:

- V-belt growth, which should have a sag of 15 mm, on manual depressing.
- Surface of V-belt grooves, which should be smooth and have no nicks or scorings. These surface blemishes cause a rapid wear of the V-belt.
- The two M 12 bolts securing the alternator bracket on the engine block, which should be done with a torque of 4.1 m.daN (30 ft.lb).
- The fastening of alternator on the bracket with slotted nut M 10, which should be done with a torque of 2.45 m.daN (18 ft.lb).
- The tightening of the M 10 nut of the belt-tensioner, which should be done with a torque of 2.45 m.daN (18 ft.lb).
- That the three pulleys, of the crankshaft, water pump and alternator, have V-belt grooves in the same plane. Maximal coplanar deviation should not exceed 0.1 mm.

  The pulleys wobbling should not exceed:

  - For crankshaft pulley (Ø 168 mm) .... 0.5 mm
  - For water pump/fan pulley (Ø 152 mm) .... 0.5 mm
  - For alternator pulley (Ø 187 mm) .... 0.16 mm

The electrical connexions on ARO vehicle should be done according to electrical diagram in Fig. 4.33.

In order to avoid any accidental short-circuit, connect the battery only after having made and checked all the other connections.

On alternator operating should be respected the technical instructions given in the OPERATOR'S HANDBOOK for ARO 24 vehicles

4.1.7. TROUBLES AND REMEDYINGS OF CYLINDER HEAD

The engine cylinder head bears on it engine timing system, inlet manifold and exhaust manifold, and its troubles are in fact, in the first place the troubles of these units and only after them, its own troubles (see Fig. 4.46).

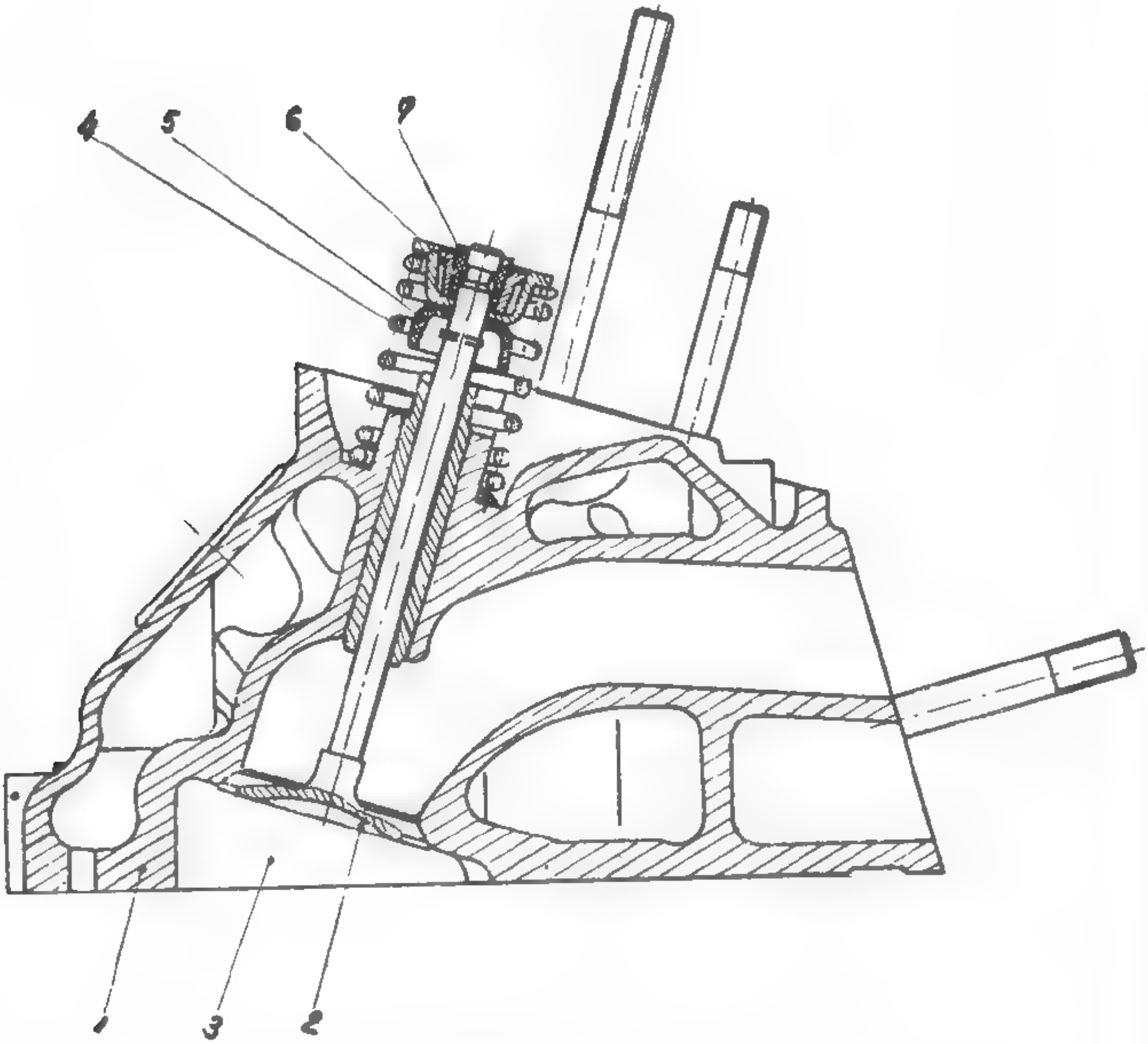


Fig. 4.46. CROSS SECTION OF CYLINDER HEAD (Assy).
1. Cylinder head body; 2. Inlet valve; 3. Combustion chamber;
4. Valve spring; 5. Protective cap; 6. Inlet valve springseat;
7. Half-cotter.

One of the frecvent troubles is the valve spring failure, which, if observed in due time, without causing damages in respective cylinder, can be remedied, without taking cylinder head down (see Op. 2.1.03.01.0).

The failure of a rocker arm can be remedied by taking rocker arm shaft down, acc. to Op. 2.1.01.29.0.

For other remedyings it is necessary to take firstly cylinder head down, being so able to perform, going on:

- Checking exhaust valves condition	(Op. 2.1.01.30.1)
- Checking inlet valves condition	(Op. 2.1.01.30.2)
- Complete cylinder head dismantling	(Op. 2.1.01.30.0)
- Removing carbon deposit from combustion chamber surface	(Op. 2.1.03.02.0)
- Checking clearance between valve stems guides	(Op. 3.1.03.03.0)
- Complete cylinder head overhauling	(Op. 3.1.03.04.0)
- Inspection and remedying the valves	(Op. 3.1.03.05.0)

4.1.7.1. STANDARD DIMENSIONS CLEARANCES OF CYLINDER HEAD COMPONENTS (Dimension figures in mm)

- Diameter of bores for valve guides;	
- inlet valve	16.000 - 16.027
- exhaust valve	17.000 - 17.027
- Diameter of large base of valve seat cone:	
- inlet valve	47.600 - 48.400
- exhaust valve	37.100 - 37.900
- Reconditioning of valve guides by processing seats up to a large base diameter of:	
- inlet valve	max. 49.0
- exhaust valve	max. 38.5
- Angle of valve seats to guides axis:	44^{0} 30' - 45^{0}
- Run out of valve seats in keeping with guide axis:	max. 0.05
- Diameter of bore for pressing exhaust valve seat in:	42.000 - 42.050

- Diameter of inlet valve seat ring to be pressed in:	42.090 - 42.125
- Distance between guide face and spring mounting face:	
- For inlet valve	19.700 - 20.300
- For exhaust valve	19.100 - 19.700
- Flatness of mounting surface for cylinder block	max. deviation 0.35 mm per 100 m or 0.1 mm per whole length
- Diameter of valve guide bore for both inlet exhaust valves:	
- standard size	9.500 - 9.522
- undersize	9.100 - 9.122
- Diameter of valve stem:	
- inlet valve	9.440 - 9.450
- exhaust valve	9.425 - 9.445
- Clearance between valve stem guide, for standard size:	
- inlet valve	0.030 - 0.062
- exhaust valve	0.055 - 0.102
- The above clearance at limit of wear:	
- inlet valve	0.112
- exhaust valve	0.152
- Diameter of valve head:	
- inlet	48.75 - 49.00
- exhaust	38.25 - 38.50
- Deviation from straightness of inlet & exhaust valve stems:	max. 0.015 per 100 mm
- Angle of valve bevel-edge:	$45^{\circ}\ 30' - 46^{\circ}$

4.1.7.2. REMEDYING THE CYLINDER HEAD

OP. 2.1.03.01.0 RENEWAL OF VALVE SPRINGS (WITHOUT TAKING DOWN THE CYLINDER HEAD)

- Take down cylinder head cover, acc. to Op. 2.0.01.21.1., after having previously completely drained the engine oil sump (1 - 2 hours after engine stopping).
- Unscrew completely rocker arm adjusting screw,
- Unscrew spark plug facing respective valve.

- Screw in the free threaded hole D 7 device, as shown in Fig. 4.47. pos. 1

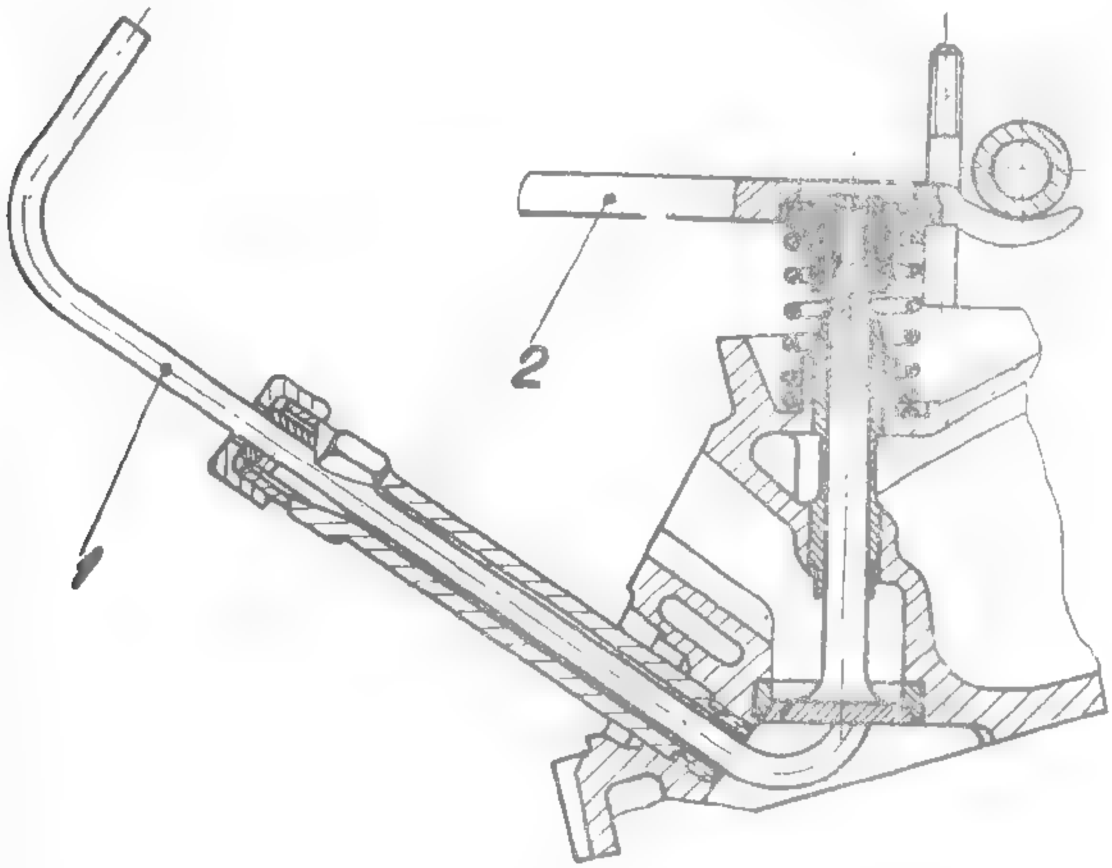


Fig. 4.47. REPLACING VALVE SPRING WITHOUT TAKING CYLINDER HEAD DOWN, BY MEANS OF D-6 D-7 DEVICES.
1. D-7 device; 2. D-6 device.

Run out of bevel-edge in keeping with valve stem 0, 035

- Distance between assembled disc bottom valve stem for exhaust valve (see Fig. 4. 48): 0. 010 - 0. 100

The valve spring can be made of steel wire, having a diameter of 4, 5 - 4, 7 mm, to which correspond the following features:

Spring features	Unit of measure	ø 4, 5 mm	ø 4, 7 mm
Length of spring in free state	mm	54. 0 - 56. 0	53. 5 - 55. 0
Stress of valve spring depressed to 47 mm	daN	25. 25 - 28. 75	24. 75 - 28. 25
Stress of valve spring depressed to 36. 5 mm	daN	59. 00 - 67. 00	61. 00 - 69. 00

- Nonperpendicularity of valve spring generatrix to supporting surface: max. 1. 10 mm per 55 mm

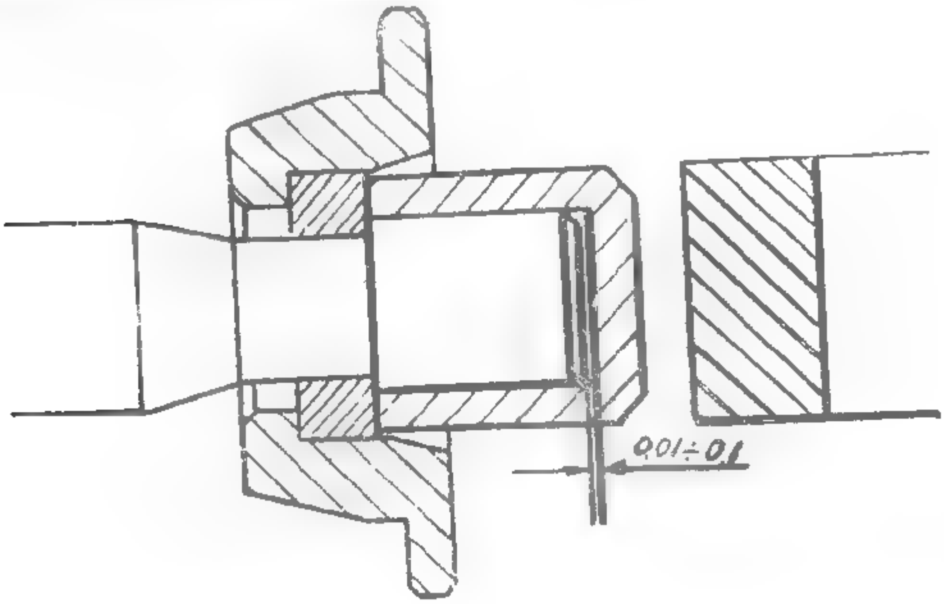


Fig. 4. 48. MEASURING DISTANCE BETWEEN VALVE STEM END AND DISC, BY MEANS OF V-5 CHECKER

- Shift aside the rocker arm and introduce under rocker arm shaft the lever of D-6 device (see Fig. 4.47, pos. 2).
- Compress the spring and remove half-cotters and valve spring seat (see Fig. 4.46 pos. 7 and 6).
- Slacken slowly faulty spring and remove it.
- Introduce the new, original spring and refit the components in reverse order (Fig. 4.46).

OP. CHECKING EXHAUST VALVE CONDITION

- Remove cylinder head cover, acc. to Op. 2.0.01.21.1
- Remove the spring of checked valve, ac. to Op. 2.1.03.01.0, and after that remove also D-6 device.
- Bring piston of respective cylinder near its inner dead center (IDC) so as to not let valve to fall into cylinder.
- Slacken D-7 device and when the valve is free, measure the clearance the valve and its guide, which should be comprised between 0.055 and 0.102 (at limit of wear: 0.152). If the clearance exceedes 0.152 mm a complex overhauling of the whole cylinder head should be performed.

OP. 2.1.03.30.2 CHECKING INLET VALVE CONDITION

- Remove cylinder head cover, acc. to Op. 2.0.01.21.1
- Remove spring of respective valve, acc. to Op. 2.1.03.01.0 and remov D 6 device.
- Going on, proceed similarly as with exhaust valve (Op. 2.1.01.30.1), with the difference that the clearance between inlet valve stem and its guide should be of 0.03 - 0,062 mm (at limit of wear 0.112 mm).

OP. 2.1.01.29.0 TAKING DOWN ROCKER ARM SHAFT ASSEMBLY AND DISMANTLING IT

- Remove cylinder head cover, acc. to Op. 2.0.01.21.1, 1 - 2 hours after engine stopping.

- Unscrew nuts and bolts securing rocker arm shaft.
- Remove oil pipe and pipe clamping plate.
- Remove rocker arm shaft assembly.
- Lift out oil scoops and push rods.

REMARK: The push rods should be marked by a number and carefully deposited in a separate box so as to be mountd in the same order.

- Remove split pins from both ends of rocker arm shaft. Remove then plain washers and spring washers.
- Remove all rocker arms, spacer springs and shaft supports from off the shaft.
- In case it should be necessary to remove both plugs from ends of shaft, bore a hole through one plug, introduse a rod through the hole and thrust plug from the other end. Introduce rod in the latter and thrust out remains of the first plug (see Fig. 4.49).

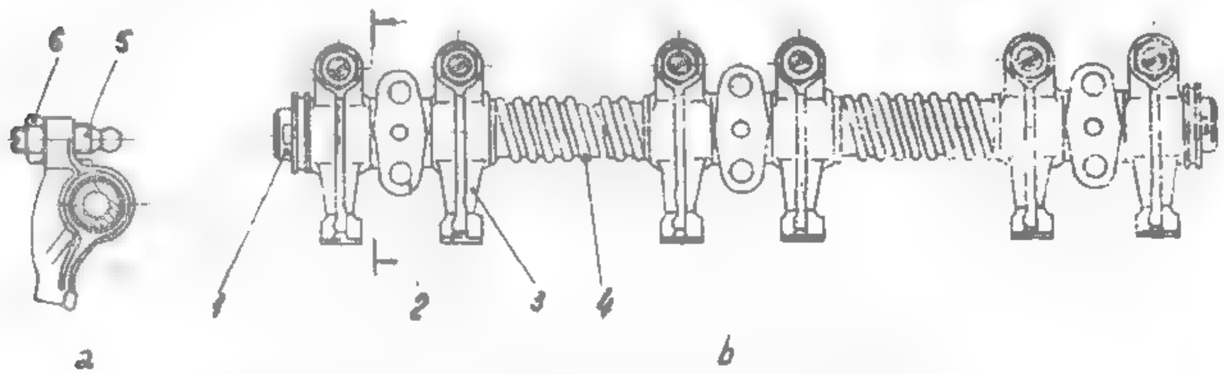


Fig. 4.49. ROCKER ARM SHAFT (Assy)
1. Rocker arm shaft; 2. Rocker arm shaft support; 3. Rocker arm; 4. Spacer spring; 5. Adjusting screw; 6. M 9 x 1 special nut, locking the adjusting screw.

- Before checking, clean thoroughly all components of shaft assembly. After cleaning check if all oil passages are free.
- Check rocker arm bores and shaft for any scratches, or traces of blows on mounting surfaces. The lighter surface flaws may be removed by honing with a fine-grit stone.

- If the rocker arm has a marked wear and concavity on the end conttrolling the valve, it should be replaced. The restoring of surface curvature by grinding is not allowed.
- Examine the adjusting screw and corresponding threaded hole to ascertain if thread is not damaged. Check spherical end of adjusting screw to see if it bears scratches, cracks, traces of seizing or unusual wear.

STANDARD DIMENSION FIGURES CLEARANCES: (mm)

- Outer diameter of rocker arm shaft:	19.979 - 20.000
- Bore diameter of rocker arm shaft supports:	20.025 - 20.065
- Bore diameter of rocker arm:	20.025 - 20.065
- Clearance between rocker arm shaft and rocker arm:	0.025 - 0.086
- Clearance at limit of wear:	0.150 mm

- Check integrity of spacer springs
- Check oil pipe for cracks and constricted bends.
- Check run out of push rods by means of comparator (see Fig. 4.50).

Maximal run out should be 0.5 mm per whole length Run outs between 0.3 to 3.0 mm can be rectified on a press. Push rods with over 3.0 mm run out should be replaced by new, original pieces.

On assembling rocker arm shaft:

- Lubricate firstly mounting surfaces of rocker arms, supports and shaft, after having checked and wiped them.
- Plug both ends of rocker arm shaft, in case plugs have been removed.
- Introduce a split pin at one end of shaft, fit on a washer, a spring washer and again a washer. Mount the rocker arms, supports and spacer srpings in the order shown in Fig. 4.49.
- Complete the assembly by fitting on both washers and spring washer.
- Introduce the second split pin and secure both pins by bending them.

OP. 2.1.01.30 TAKING DOWN AND DISMANTLING CYLINDER HEAD ASSY

REMARK: The cylinder head should be taken down only when engine is cold and cooling system completely drained (see Op. 2.0.13.04.0).

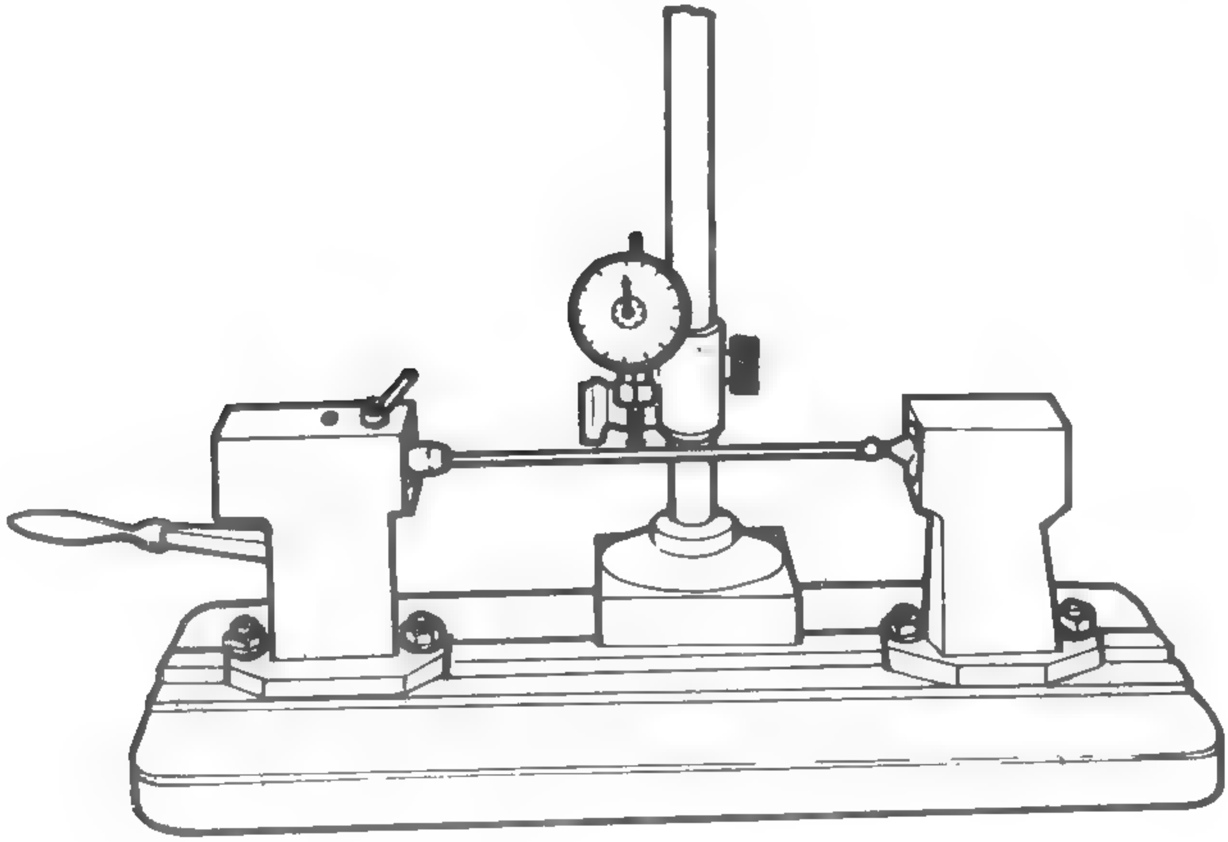


Fig. 4.50. CHECKING PUSH RODS.

- Disconnect carburettor from fuel pump and from accelerator throttle linkage.
- Disconnect connections between cylinder head and air cleaner, thermostat elbow and cylinder head, respectively inlet manifold, between carburettor and air cleaner.
- Undo connection between cylinder head and heating system,
- Disconnect muffle exhaust pipe.
- Disconnect exhaust manifolds (central and outer).
- Take down inlet manifold together with carburettor and thermostat elbow.
- Take down cylinder head cover, acc. to Op. 2.0.01.21.1.
- Take down rocker arm shaft assy and remove push rods, after having marked them by numbers.
- Unscrew bolts securing cylinder head on engine block, in opposite order to that on tightening them.

- Lift cylinder head from cylinder block. Do not use a lever or sharp tools in order to avoid damaging of mounting surfaces.
- Carefully detach cylinder head gasket
- IMPORTANT! After removing cylinder head cover cylinder block in order to avoid penetrating of impurities into lubricating circuit and block cylinders.
- On refitting cylinder head on block performe all operations in reverse order.

DISMANTLING CYLINDER HEAD ASSY.

- REMARK: Before removing the valves, clean the combustion chambers, so as to protect valve seats,
- By means of D 6 device take down in succession exhaust and inlet valves (see Fig. 4.47) (see Op. 2.1.03.01.0). Press down the spring and remove the two half cotters. By releasing the lever, the valve spring extends completely and can be removed together with the valve spring seat.
- Remove protective cap.
- Turn over cylinder head and mark valves, after which remove them one by one and place them in a special stand, in view of refitting them in the same order.
- After having performed all necessary overhauling of cylinder head as below described, refit it on cylinder block in reverse order as on taking it down and dismantling.

OP. CLEANING & CECKING THE CYLINDER HEAD

- Score with a scraper or wire brush the carbon deposit on surface of combustion chambers and valves. Perform this cleaning before removeng the valves, so as to protect vaive seats.

  Take great care not to damage mounting surface, by scratching or applying any blows!
- Remove resulted material, by scoring, using a clean brush. Remove it also from valve guides, after having remove the valves.

Wash remaining dirt and grease, with an alkaline solution or with white-spirit, after which dry by blasting with compressed air.

OP. 3.1.03.03.0. CHECKING CLEARANCE BETWEEN VALVE STEMS GUIDES

- After having performed the above described operations for taking down dismantling cylinder head:

Remove the valves, using D 6 device, so as it is shown in Fig. 4.51.

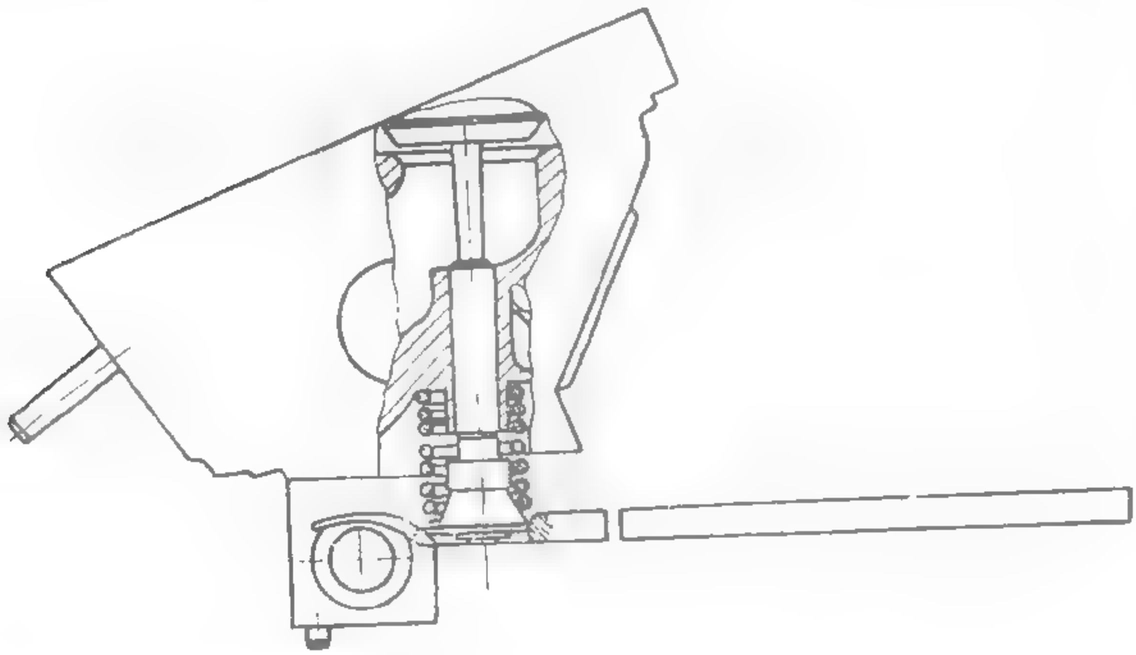


Fig. 4.51. TAKING VALVES FROM CYLINDER HEAD DOWN, BY MEANS OF D-6 DEVICE.

REMARK: On removing valves, mark each valve and respective place on cylinder head, in order to refit them in the same order.

Clean all components with organic solvents, untill they get clean, and dry them by air blasting. Take special care to avoid any fire danger!

Fasten cylinder head in D 21 fastening devices, in order to protect its working surfaces.

- Introduce the valves, one by one, in respective guides and measure [illegible] clearance, using D 12 device, as shown in Fig. 4.52, acc. to indications given in Op. 2.1.03.03.4.

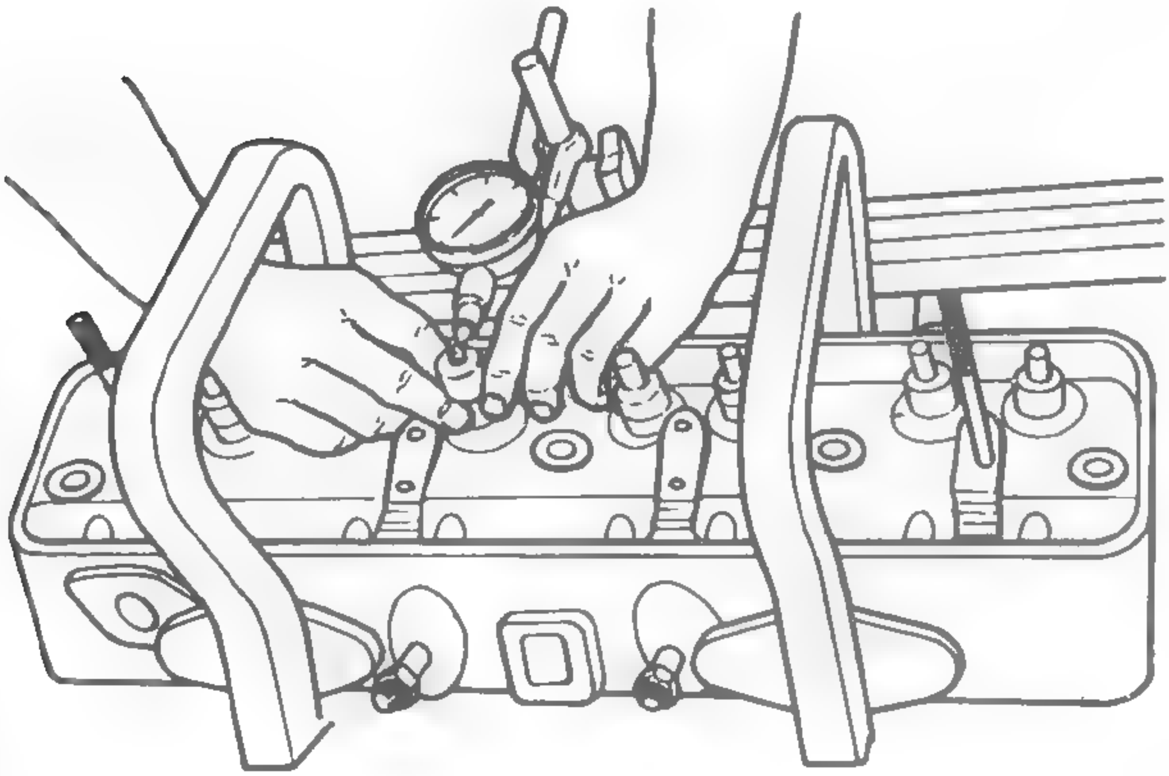
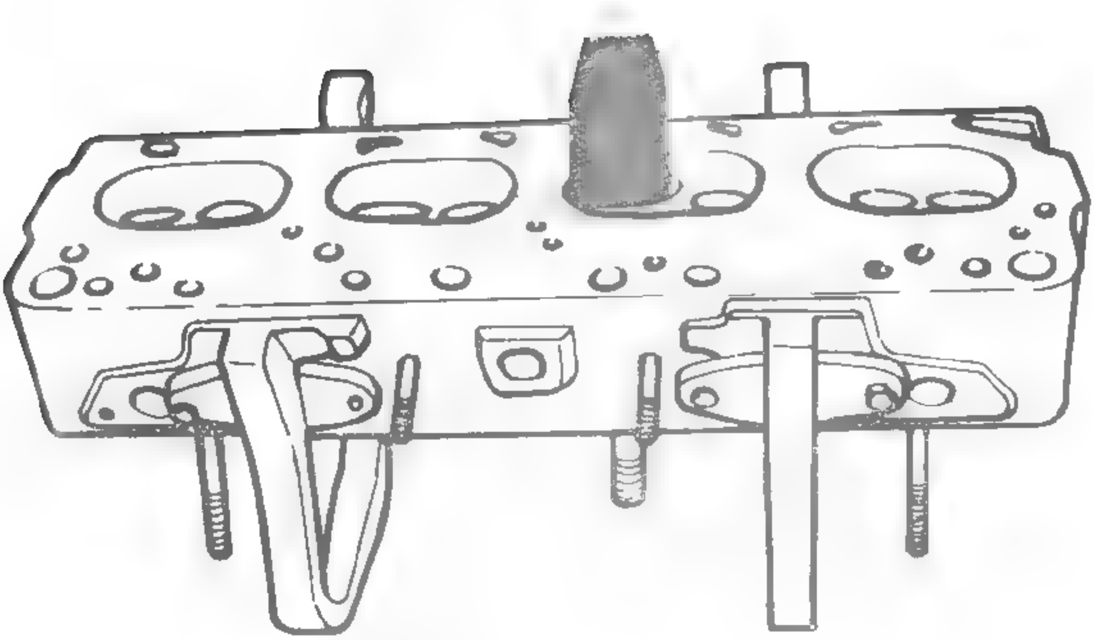


Fig. 4.52. CHECKING CLEARANCE BETWEEN VALVE STEM AND GUIDE, BY MEANS OF D-12 DEVICE.

In case that the measured clearances exceed the values indicated at 4.1.7.1., replaces respective guides by means of D 8 device, so as it [illegible] shown if Fig. 4.53.

IMPORTANT. The replaced valves should be grinded on their stem, in order to obtain the clearances indicated at 4.1.7.1.

- Before refitting the valves on cylinder head performe checking and complete remedying of cylinder head body, as follows:



OP. 3. 1. 03. 04. 0. COMPLETE REMEDYING OF CYLINDER HEAD BODY

Ater having taken down, dismantled and cleaned cylinder head, as above [illegible]ribed, fasten it in D-21 device, for inspection

Check if cylinder head sealing surface is not damaged.

Small blow traces or scratches should be grinded using a fine-grit stone.

Check cylinder head for fissures. To desc[illegible] v[illegible]ry fine fissures, unvisible with the naked eye, perform as follows

Smear surface suspected of fissures with [illegible] [illegible]ing 25 [illegible] kero sene 75 % thin engine oil. Wipe then [illegible] [illegible]mmediately of [illegible]xide dissolved in methylic alcohol [illegible] [illegible]will [illegible]olour in that place

A fissured cylinder head should be renewed.

- Check valve seats for excessive wear or cracks. Check also exhaust valve seat rings for play.
- Check flatness of cylinder head mounting surface (see Fig. 4. 54).

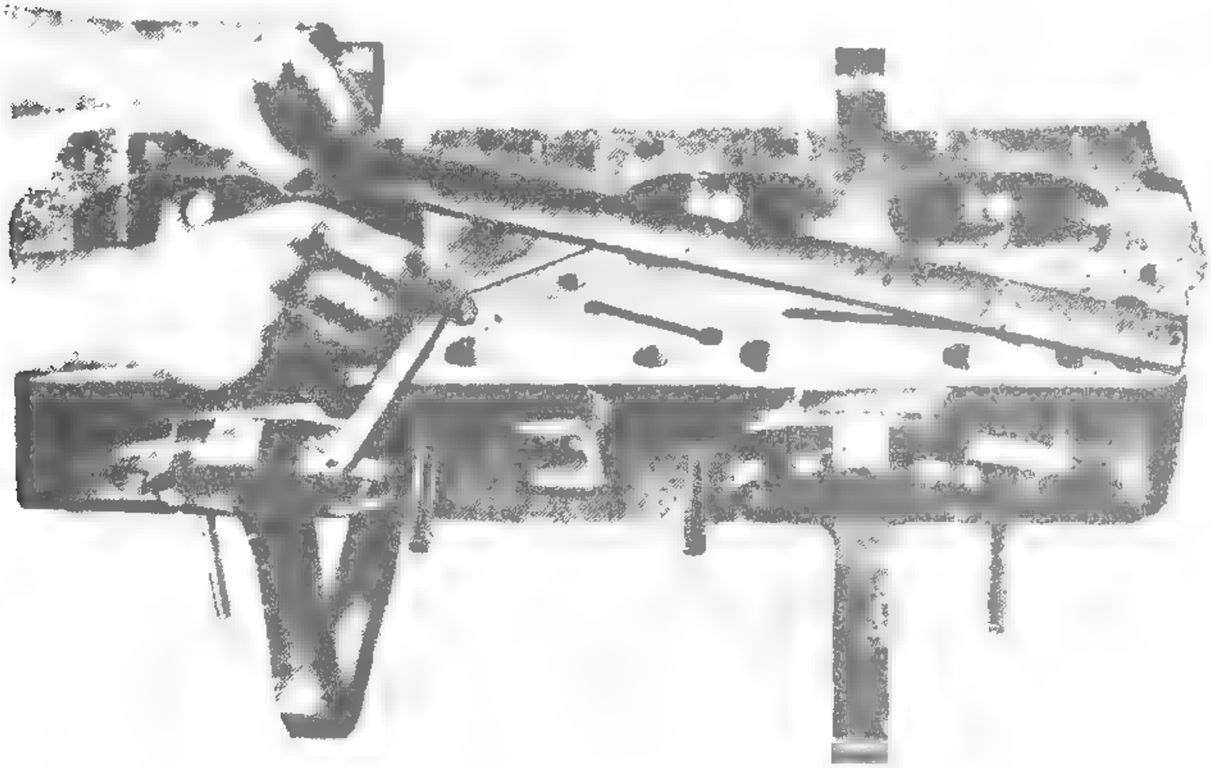


Fig. 4, 54. CHECKING FLATNESS OF CYLINDER HEAD (see Fig. 4. 17).

Max. allowed deviation is 0. 035 mm per 100 mm, or 0. 1 mm per whole length. Cylinder head with flatness deviation exceeding above limits shuld be trued up. In no case the amount of stock removed from the mounting surface exceed 0. 25 mm.

- Check volume of combustion chambers, which should be in limit 94 $\pm$ 2. 5cm^3. Inner surface of combustion chambers with smaller volumes should be touched up uniformly, by grinding, till chamber volume reaches above mentioned figure.
- Check radial run out of valve seats, by means of the V 2 dial gauge checker. Maximal deviaton should not exceed 0. 05 mm.

Check large diameter of valve seat cone frustum, using for inlet exhaust valves the dial gauges checkers V 2 and V 3.

If, because of wear, max. allowed clearance, between inlet & exhaust valve stems and respective guides, exceeds the prescribed limits, the worn out valve guides should be replaced by undersize new guides. In such a case the valve to be introduced in the new replaced guide should be grinded untill the prescribed clearance is obtained (see §4. 1. 7. 1.).

To replace valve guide, extract worn guide by means of D 8 device (see Fig. 4. 53), which rests on the valve spring recess, machined on cylinder head.

- The reconditioning of valve seats should be undertaken only after replacying the worn valve guides and after fitting in valves with rectified stems. The valve seats have to be trued up and should be perfectly concentric to contact surface of valve seats. This precaution is necessary so that the valves should fit perfectly on their seats and ensured good compression in cylinders and a good vacuum in inlet manifold.

The valve seat, after being trued up, must contact the central or outer zone of the valve bevel edge. To check zone of contact, between bevel edge of valve and bevel seat, smear valve seat with Prussian blue, mount the valve in guide and rotate, pressing it slightly down on seat. If Prussian blue traces are on middle or outer zone of valve bevel surface, the contact is true. If Prussian blue traces are on inner zone of valve bevel edge, the seats should be trued up anew.

- Reconditioning of cylinder head valve seats should be done at an angle of $44^{\circ}50' - 45^{\circ}$, both for inlet and exhaust valves. (see Fig. 4. 55).

Performe the touching up of inlet valve seat, using S 3 milling cutter, and for exhaust valve seat, S 5 milling cutter.

When reconditioning valve seats do not mill away more material than is absolutely necessary to smooth roughness and grooves or to corect excentricity of seat. N e v e r exceed a large base diameter of 49 mm for inlet valve seats and 38. 5 mm for exhaust valve seats.

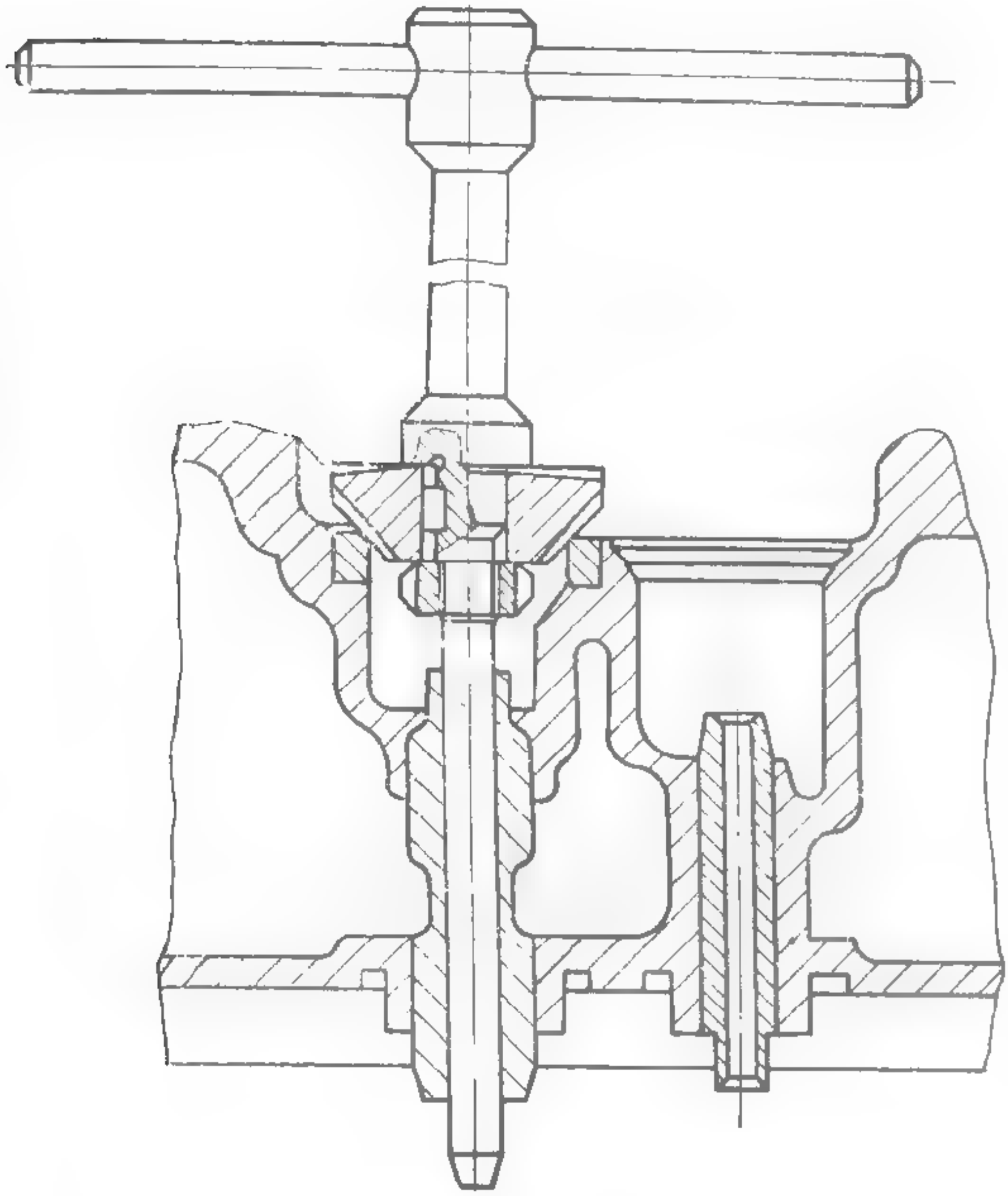


Fig. 4.55. RECONDITIONING VALVE SEAT BY MEANS OF S-3, S-4 and S-5 DEVICES

- After having reconditioned the contact surface of seat, measure resulting width of seat. This width should be within the limits of 1.1 - 1,4 mm for inlet and 1.2 - 1.7 mm for exhaust valve seats.
- If above mentioned values are exceeded the width should be brought within established limits, by milling away material, either from large or from small base of valve seat frustum. To do this, check by means of Prussian

method, described above According to the obtained results, mill ... material from large base of frustu using the S 6 end milling cutter, ... o lift the seat edge, mill away material from the small base of frustum, using 60^{o} -tapered milling cutter (S 7).

After having reconditioned seats by milling or grinding it is advisable to lap seats lightly, using a middle-grit lapping compound and D 9 lapping device.

If it will be necessary, remove the exhaust valve seat ring, using D 10 device. The new valve seat ring, which is to be pressed in, should be selected so as to be tightened within a limit of 0.04 - 0.125 mm. A lesser tightening is not to be allowed.

To introduce seat ring in its recess (in workshop conditions), the cylinder head should be heated to ~ 80^{o} - 90^{o}C (176 - 194^{o}F) in hot water. The ring ... is set on the special S 8 drift with care as to its final position. The drift being piloted by valve guide, introduce ring in recess by light hammer taps on drift till ring is snug. Work with the utmost dispatch not to lose the benifit derived from the heated cylinder head.

... other operations of cylinder head overhauling, refit val... the components, mount cylinder head on engine block and tighten ... bolts, acc. to Op. 2.0.01.17.0.

... cooling system with cooling fluid, acc. to Op. 2.0.13.09.0. and check it for tightness, acc. to Op. 2.0.13.06.0.

OP. 3.1.03.05.0 INSPECTION, CHECKING & REMEDYING OF ...VES

... this operation at the ... time ... com... cylinder head ..., the preliminary and ... fitting ope...ons bein... already included. ... inspection, clean valves of ... deposit by means of ... wire brush. Wash them after it with an adequate solvent.

... inspect valve heads for traces of cinder, scorings, cracks, nicks, ... and fissures, inspect also ... The

valves having any of the above mentioned faults in a major form shouid be replaced. The lesser flaws, minor nicks and scratches may be amended.

- Check in the same manner the other components of the valve assy i.e. valve spring, spring seat, half discs & half cotters. The fualty parts should be replaced.
- Check radial run out of the valve bevel edge by means of D 11 dial gauge checker, as shown in Fig. 4.56.

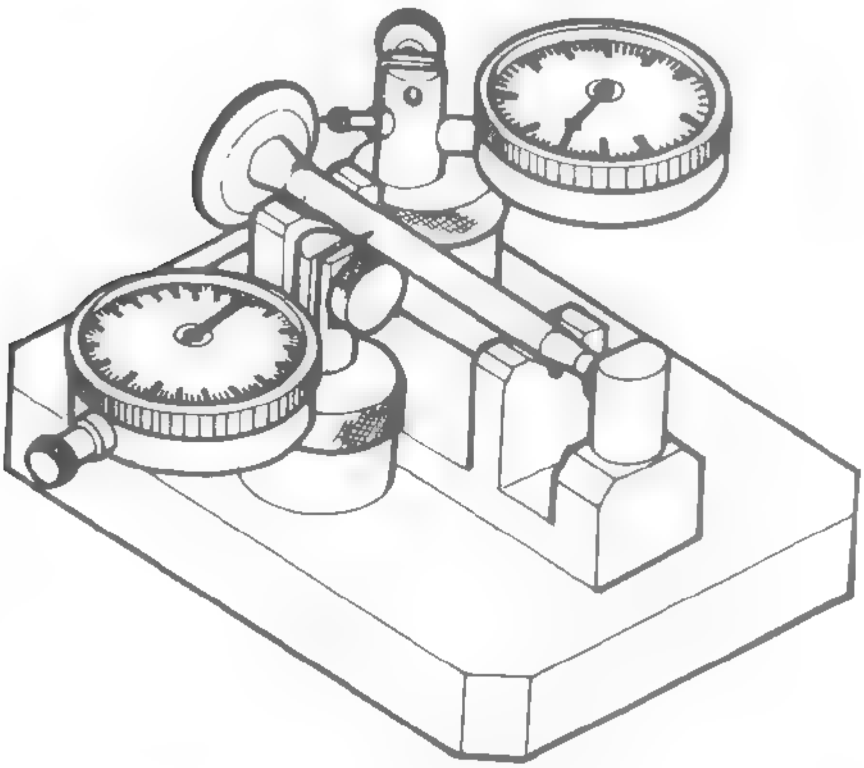


Fig. 4.56. CHECKING VALVES BY MEANS OF D-11 DEVICE.

The max. allowed run out of valve bevel edge, in keeping with valve stem, is 0.035 mm (see 4.1.7.1.).

In the same instance, on the same device, check straightness of valve stems. For max. deviation from straightness see &4.1.7.1.

- For checking clearance between valve stem and its guide, introduce valves in their guides, respecting prior made markings,
- Perform checking of clearance by means of D 12 dial gauge device. Fit device on end of valve stem and lock it by means of screws.

  Allow the valve to slip out of its place (valve bevel edge no longer resting on valve seat) till the device stops on valve end and contacts valve guide
- Fasten support of dial gauge on cylinder head and apply the pick-up of dial gauge to central zone of device sphere, so that it should be at aproximately right angle to valve stem (see fig. 4.52).
- Take dial readings when device is pushed towards the dial gauge and again when it is pushed back to ful extent, taking care that it should not lift up off surface of valve guide. The resulting dial gauge indications should be divided by two, so as to obtain actual clearance. In case that this clearance exceeds maximal wear limit, change the worn guide and grind the valve stem up to undersize, corresponding to the new guide.

  Check compressive force of valve spring by depressing spring on a device for measuring spring stress. The resulted stress values should be within the limits specified in &4.1.7.1.

  Check perpendicularity of valve spring supporting surface by means of a platen and square. Set spring on platen with coils touching square. Rotate spring slowly and note distance between top loop and square. If distance exceeds the allowed limit (see &4.1.7.1.), the spring should be replaced.

VALVE GRINDING

If clearance between valve stem and its guide exceeds the limit of wear (0.112 mm for inlet valves and 0.152 mm for exhaust valves), replace worn valve guide with an undersize new guide. The latter has a smaller bore and thus it gets necessary to grind the valve stem up to an undersize dia- ... as to respect the prescribed clearance (inlet valve 0.03 - ... exhaust valve : 0.055 - 0.102 mm).

REMARK : Note that the reconditioning of the valve seats should be undertaken only after having set the valve guides to rights.

- The grinding of valve bevel edge should concur with grinding of valve seat.
- The valve bevel edge should be ground when run out exceeds limit of 0.035 mm or when scorings, scratches or fissures must be removed.
- The grinding should be done at an angle of $45^{o}30' - 46^{o}$, taking care that grinding wheels be correctly cut and dressed in time. One should not grind away more stock than strictly necessary to the removal of nicks, scorings, cracks or runout. Do not remove more than 0.2 mm from end of valve stem.
- After grinding remake a chamfer of 0.5×45^{o} on inlet valve and of 1×45^{o} on exhaust valve stem end.
- After having ground the bevel edges of both valve and seat, lap seat with valve, using a lapping compound of medium grain. After lapping remove compound from valves and seats.
- New or rectified valves should be cleaned with an organic [illegible] ethylene, thinner, etc.). After cleaning, coat stems of [illegible] denum disulfide ("Molycote") powder, using a smooth leather [illegible] in order to make molycote powder adhere as better as possible on the valve surface.
- Now, smear valve stems with grease with molycote, or if not available with graphite (10%). These operations should be done only prior to mounting valves in guides (to avoid collecting of impurities from air.

REASSEMBLY OF CYLINDER HEAD

- Before mounting the exhaust valves measure the distance between end of valve stem and bottom of disc, by means of V 5 micrometrical device, as shown in Fig. 4.48. The correct distance is 0.01 - 0.10 mm and its purpose is to allow valve rotation by the disc (valve spring seat) taking over the reaction of the valve spring, when valve is actuated by rocker arm. If distance is more that 0.10 mm, it should be reduced by honing the free area of the disc, on a flat surface.

introduce each valve in its guide, according to markings on disassembly,The valve stems should be smeared with graphite oil. The ground stems or new valve stems should be coated with molycote (MoS_2), as shown above.

- Mount all parts, composing valve assembly (see Fig. 4.46) in the following order: Fit protective cap (5) on valve stem, with concavity downwards; fit on spring and valve spring seat.
- Depress springs by means of D 7 and D 6 devices, for removing refitting valves, as shown in Fig. 4.47. Fit half discs & discs on exhaust valves and inlet cotters & halft cotters on inlet valves. On releasing valve spring take care that half-discs and half- cotters settle down correctly in their places. This operation should be repeated for each inlet & exhaust valve.

4.1.8. FAULTS & REPAIRS OF MANIFOLDS AND AIR CLEANER

4.1.8.1. GENERAL DISCRIPTION OF COMPONENTS

The inlet manifold is an aluminium casting, fastened on cylinder head with bolts at its ends and by the agency of two ball clamps on its central area. Between manifold and cylinder head is fastened a thermostable gasket.

On inlet manifold is fastened the carburettor, insulated from manifold temperature by the agency of a thermoinsulating gasket.

The exhaust manifold is a grey iron casting, consisting of two separate components: an outer manifold, for cylinders 1 and 4, and a central manifold, for cylinders 2 and 3, both fastened on cylinder head with bolts. Between manifolds and cylinder head are included gaskets resisting at high temperature.

The air cleaner, of wet type, consists of a housing, in which is set a filtering element and a baffle pan, which provide air filtering.

At the bottom of filter housing is an oil sump, which retains impurities (see Fig. 4.57).

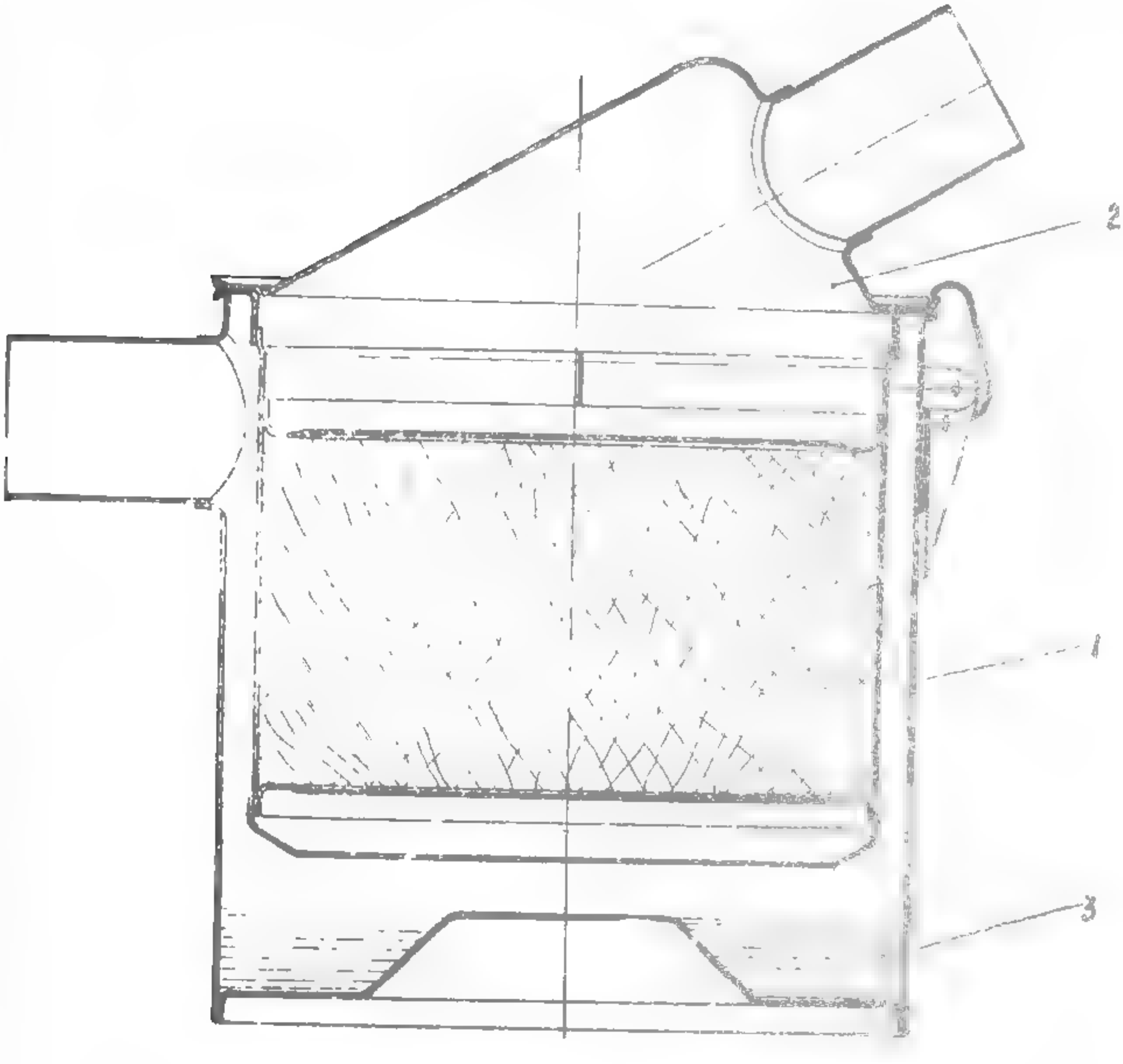


Fig. 4. 57. CROSS SECTION OF AIR CLEANER.
1. Air cleaner housing; 2. Filter element (assy); 3. Oil bath.

4.1.8.2. TROUBLES AND THEIR REMEDYNG

Inlet manifold can get pores, as hidden flow of casting, which cause air inleakages (see Op 2. 0. 08. 02. 0). The same trouble (air inleakage) can occur due to broken gasket, between manifold and cylinder head. For remedying, the pores can be sealed (Op. 2. 1. 08. 02. 0) respectively the faulty gasket should be replaced (Op. 2. 1. 08. 02. 1), after having prior taken manifold down from engine

If exhaust manifold has hidden casting flows, it should be replaced (Op. 2. 1. 08. 08. 0), after having taken it down from engine (see Op. 2. 1. 08. 04. 0). If there are leakages of exhaust gases, the faulty gaskets, between manifolds and cylinder head should be replaced (Op. 2. 1. 08. 09. 0).

If engine runs only at low speed, it can be caused by clogged air cleaner, which should be checked and cleaned (Op. 2. 0. 08. 03. 0).

OP. 2. 0. 08. 03. 0 CHECKING AIR CLEANER FOR CLOGGING, EVENTUALLY ITS CLEANING

- Disconnect air cleaner from carburetor, undoing hose clamp on air cleaner connecting pipe.
- Disconect air cleaner from cylinder head cover, undoing bleeding hose from air cleaner respective connecting pipe.
- Undo clamps and remove cover, together with filtering element, and check pollution condition of filtering element and of oil from housing oil sump. If necessary, clean all components acc to Op. 2. 0. 01. 06. 0.
- Refit all components in reverse order.

OP. 2. 0. 08. 03. 0 CHECKING AIR INLEAKAGES

- Undo connection between air cleaner and carburettor, removing clamp air hose on carburettor adapter.
- Disconnect fuel supply pipe from carburettor socket.
- Seal carburettor inlet sockets for air and fuel.
- Check cylinder 1 for compression, acc. to Op. 2. 0. 01. 39. 0. If cylinder 1 does not hold compression, try with another, corresponding cylinder. If, due to excessive wear of cylinders or piston rings no one cylinders holds compression, the air inlikages should be checked during complexe engine overhauling.
- If you will find a cylinder with good compression, unscrew spark plug of respective cylinder and, after having brought its piston in inner dead

centre, mount a vacuum-meter. If the latter is not available, seal the spark plug hole with a threaded plug.

- Turn the crankshaft for bringing piston in its outer dead centre. In this situation the resulted vacuum should keep over one minute, eventually with small decrease. If vacuum does not hold, it means that there are air inleakages in the gasket between carburettor and inlet manifold, in the gasket between inlet manifold and cylinder head or through the pores of inlet manifold.

After checking, refit all connections in reverse order.

OP. 2.0.01.39.0 CHECKING CYLINDERS FOR COMPRESSION

- Turn crankshaft and bring piston in its outer dead centre, to the end of inlet cycle (prove this with the hand, pressed on the respective spark plug hole).
- Instead the spark plug mount a manometer (pressure gauge) for 25 bars.
- Turn crankshaft again and bring piston in its inner dead centre, when compression reaches its maximal value. The resulted pressure should keep at least half a minute, or its decrease should be below 10%. If not, the sealing of piston rings on cylinder wall is no more sufficient, due to excessive wears and the trouble should be remedied on general overhauling of dismentled engine.
- After checking, remove manometer and mount back spark plug.

OP. 2.0.08.05.0 TAKING CARBURETTOR DOWN FROM INLET MANIFOLD

- Undo connection between air cleaner and carburettor, removing clamp fastening air hose on carburettor adapter.
- Remove connection between carburettor and fuel pump, removing respective fuel supply pipe.
- Remove acceleration throttle and choke control leankages.

- Unscrew bolts fastening carburettor on inlet manifold, removing then carburettor together with sealing and thermoinsulating gaskets. On refitting carburettor, perform operations in reverse order.

OP. 2.1.08.05.1 REPLACING GASKETS BETWEEN CARBURETTOR AND INLET MANIFOLD

- Take carburettor down, acc. to Op. 2.0.08.05.0.
- Check if cardboard gaskets have traces of smoking, which indicate the zones of air inleakage.
- If the cardboard gaskets are safe, but there are although air leakages in the engine, check insulating gasket, which should have no scratches, nicks, lacks of material, etc. faults which cause air inleakage. The flatness deviation of insulating gasket should not exceed 0.03 mm per whole length. The same allowed deviation is for its thickness. If necessary, it can be trued up on a abrasive paper, laid on a metalic surface of adecquate flantness.
- Check in the same manner the mounting surfaces of carburettor and of inlet manififold. Eventual blows or caulkings will be removed using a fine grit stone.
- Faulty cardboard gaskets and insulating gaskets which cannot be remedied, will be replaced with new, good ones.

OP. 2.0.08.06.0 TAKING INLET MANIFOLD DOWN

- Take carburettor down, acc to Op. 2.0.08.05.0.
- Disconnect inlet manifold from hoses connecting it with cylinder head and thermostat elbow.
- Unscrew bolts fastening inlet manifold on cylinder head, removing it together with respective sealing gaskets.

  On refitting inlet manifold on cylinder head, performe operations in reverse order.

OP. 2. 1. 0. 08. 02. 1 REPLACING INLET MANIFOLD GASKETS

- Take carburettor down acc. to Op. 2. 0. 08. 05. 0.
- Take inlet manifold down, acc. to Op. 2. 0. 08. 06. 0.
- Replace faulty gaskets.
- On refitting inlet manifold on cylinder head, tighten fastening bolts with a torque of 6. 5 - 7 daNm (mkg). On refitting perform operation in reverse order.

OP. 2. 1. 0. 08. 07. 0 SEALING PORES OF INLET MANIFOLD

- Take carburettor down from inlet manifold, acc. to Op. 2 0 08. 05. 0.
- Take inlet manifold down, acc. to Op. 2. 0. 08. 06. 0.
- Check hot water chamber of inlet manifold for tightness, closing tightly water inlet and introducing through outlet compressed air, under a pressure of 1. 2 bars (kg/cm^2). The pores will get evident by dipping manifold in a basin with water.
- Check in the same manner the mixture chamber of inlet manifold.
- Mark porous areas. The areas having small, but numerous pores will be sealed by coating with warm bakelite lacquer.
- The areas having big pores should be cleaned and then remedied using a metallic compound for remedying aluminium castings After compound hardening, clean respective area and remove excess of compound.
- Finaly check again, as above described, the tightness of remedied manifold, refitting it after that on cylinder head.

OP. 2. 0. 08. 04. 0 TAKING EXHAUST MANIFOLD DOWN

- Undo connections between exhaust manifolds and muffler fore pipe.
- Remove H. T. ignition leads from spark plugs.
- Unscrew bolts fastening exhaust manifolds on cylinder head, removing them and at the same time the sealing gaskets and protecting screens

On refitting, perform operations in reverse order, tightening bolts with a torque of 7 - 7.5 mdaN (50.6 - 54.2 ft.lb) and the nuts fastening mufflerfore pipe with a torque of 3 - 4 m.daN (22 - 29 ft.lbs).

OP. 2.1.08.08.0 REPLACING EXHAUST MANIFOLDS

- Take exhaust manifolds down, acc. to Op. 2.0.08.04.0.

  If the trouble of exhaust manifold consists only of a pore or a reduced fissure, the remedying is done by welding faulty area, using only cast iron electrodes. To remedy a fissure chack firstly its length and position. For this:
- Prepare a mixture of 50% kerosene and 50% thin oil and smear with it the fissured area.
- Wipe dry the smeared area and immediately apply a solution of talc in alcohol. Wait till alcohol evaporates; the fissured area will soak the talc, making so visible the respective fissure.
- At the two ends of the fissure drill two bores of 4 or 5 mm diameter.
- Chiesl off the edges of the fissure up to a depth of 2 - 3mm.
- Now weld the fissured area, inclusively the two bores.

  The exhaust manifolds, having big fissures, should be replaced.

OP. 2.1.08.09.0 REPLACING EXHAUST MANIFOLD GASKETS

- Take exhaust manifolds down, acc. to Op. 2.0.08.04.0.
- Inspect gaskets for faults, as burnings, lacks of material or fissures. The gaskets having such a faults should be replaced with original ones. The gaskets are made of reinforced klingerite.

II.1.9. OVERHAULING ARO L-25 ENGINE, TAKEN DOWN FROM VEHICLE

A number of ARO L-25 gasoline engine can be remedied only after having prior taken engine down from vehicle, when accessibility increases and allows a remedying of high quality.

4.1.9.1. DESCRIBING AND CHARACTERISTICS OF CYLINDER BLOCK AND ITS COMPONENTS

4.1.9.1.1. DIMENSION FIGURES FOR CHECKING REMEDYING CYLINDER BLOCK

The cylinder block, a grey iron casting, bears on it: main crankshaft bearings, their caps and clutch housing (see Fig. 4.58), simultaneously machined, so that these components should be dismantled only if strictly necessary, and on refitting them one should pay special attention in order to respect their initial mutual position.

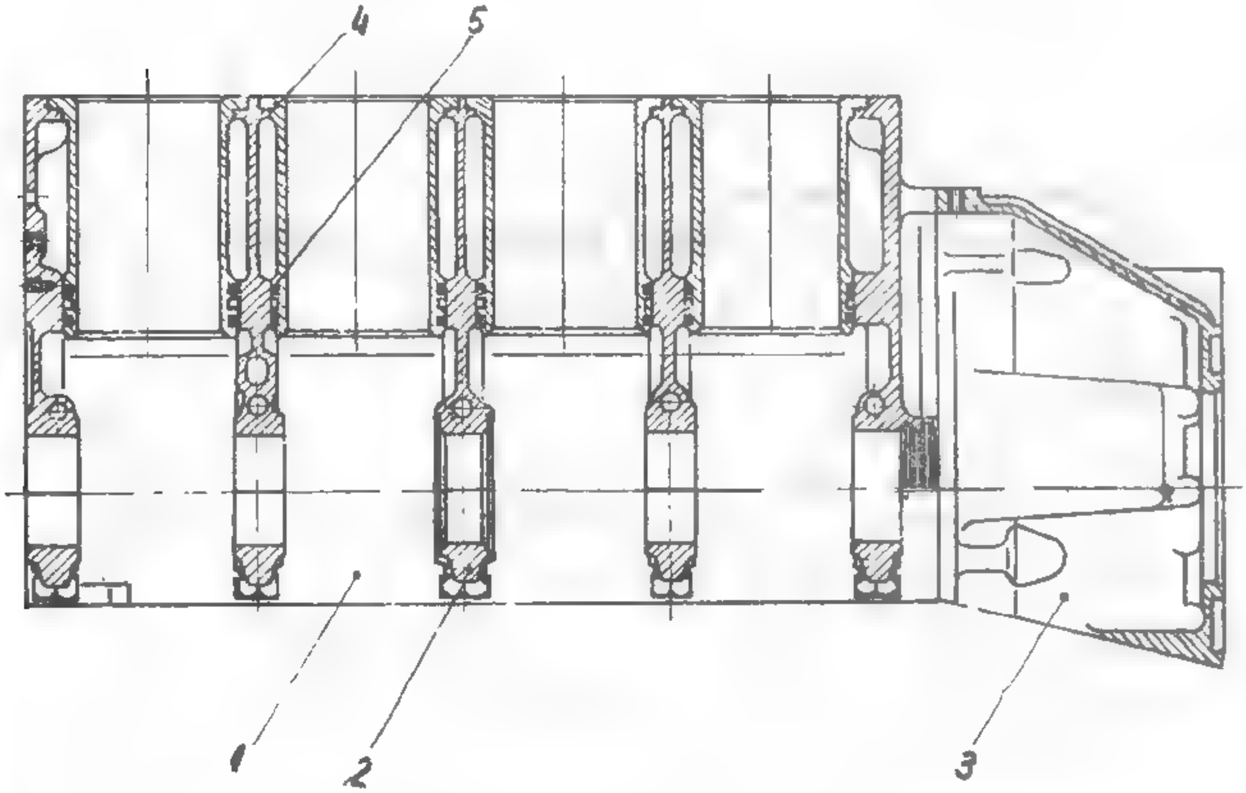


Fig. 4.58. CYLINDER BLOCK (ASSY)
1. Cylinder block; 2. Bearing cap; 3. Clutch housing; 4. Cylinder liner; 5.. Cylinder liner bottom gasket.

Dimension figures for checking & remedying cylinder block:

- Flatness of mounting surface for cylinder head	0.2 mm per whole length, or, 0.05 mm per 150 mm
- Hight of recess for cylinder liner collar:	8 + 0.050 mm
- Distances between crankshaft and camshaft axis:	115 $\pm$ 0.036 mm
- Bore diameter for camshaft bushes:	52.5 $\pm$ 0.03 mm
- Bore diameter for journal half-bearings:	70 $\pm$ 0.03 mm
- Ovality and conicity of ø 70 mm b.r : max.	0.015 mm
- Height of cylinder head mounting surface above crankshaft axis:	$250^{+0.10}_{-0.05}$ mm
- Bore diameter for distributor gear:	14.000 mm
- Standard size:	14.000 - 14.019 mm
- Oversize I:	14.500 - 14.519 mm
- Perpendicularity of tappet guide axis to camshaft axis: Maximal deviation:	0.10 mm per 100 mm
- Noncoaxiality of ø 41.3 and ø 14 + 0.019 mm bores: max.	0.05 mm
- Distance between back face of distributor and distributor gear:	79 + 0.4 mm

Dimension figures for checking & remedying clutch housing

- Runout of ø 125 + 0.04 mm, in relation to ø 70 + 0.03 mm: max.	0.08 mm
- Deviation from perpendicularity of mounting surface of gear box to ø 70 + 0.03 mm: max.	0.05 mm per 100 mm

4.1.9.1.2 DIMENSION FIGURES FOR CHECKING & REMEDYING CYLINDER LINERS

- Bore diameter of cylinder liner:

Table IX

Size	Group A	Group B	Group C
Standard size	97. 000 - 97. 018	97. 018 - 97. 036	97. 036 - 97. 054
Oversize I	97. 500 - 97. 518	97. 518 - 97. 536	97. 536 - 97. 554
Oversize II	98. 000 - 98. 018	98. 018 - 98. 036	98. 036 - 98. 054
Oversize III	98. 500 - 98. 518	98. 518 - 98. 536	98. 536 - 98. 554

- Cylinder liner bore maximum allowed ovality: 0. 013 mm
- Limit of wear: 0. 125 mm
- Cylinder liner bore maximal conicity: 0. 018 mm
- Limit of wear: 0. 200 mm

Height of cylinder liner collar: 8. 050 - 8. 080 mm

4. 1. 9. 1. 3 DIMENSION FIGURES FOR CHECKING HALF-BEARINGS, MOUNTED IN MAIN JOURNALS AND TIGHTENED WITH CAPS

Perform this checking after having mounted main crankshaft bearing caps and tightened them using a torque of 15. 4 - 16. 8 m. daN (112 - 114 ft. lbs).

- Check bearing bore; with half-bearings mounted and tightened, as above mentioned, using an inside dial gauge, set to a ling gauge.
  The measured ovality and conicity (bellmouth) should not exceed 0. 02 mm.
- Measure crankshaft journals whose deviations should not exceed 0. 012 mm.
- Check now the clearances between main bearings and journals, which should not exceed the indicated values.

4. 1. 9. 1. 4. DIMENSION FIGURES FOR CAMSHAFT.

The camshaft is a casting of special allied nodular cast iron.
It is driven by the agency of textolite distribution gear, locked on it with a Woodruff key, so as it is shown in Fig. 4. 59.

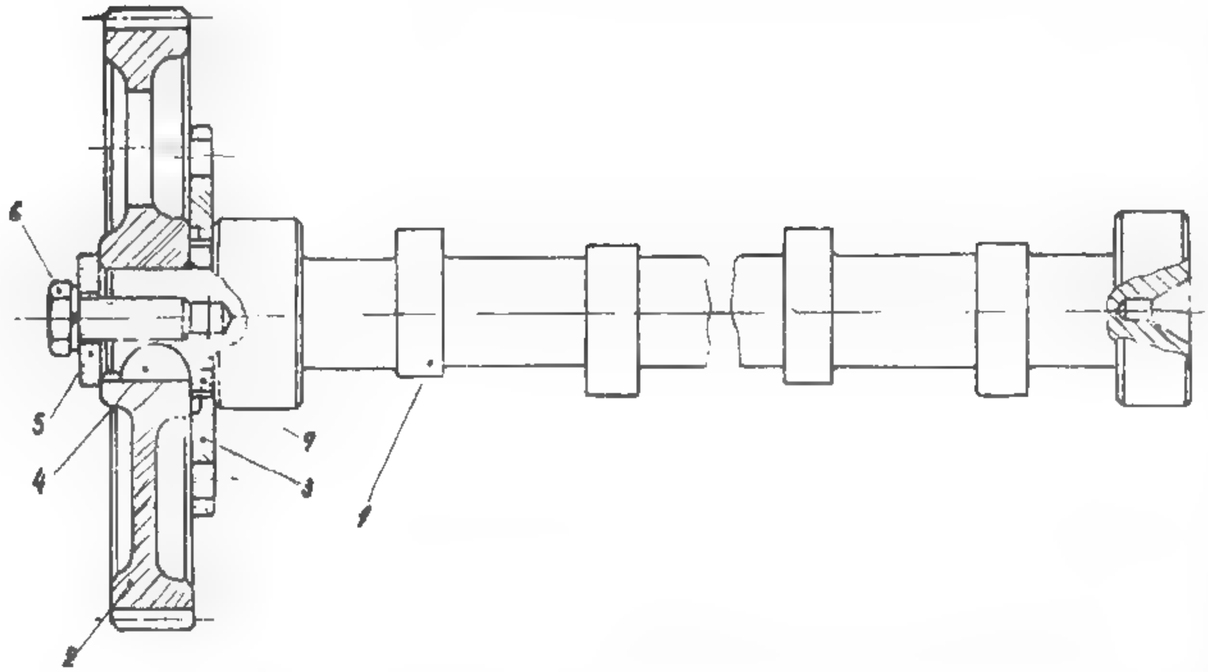


Fig. 4. 59. CAMSHAFT ASSEMBLY
1. Camshaft; 2. Camshaft drive gear; 3. Retainer flange; 4. 4 x 8 Woodruff key; 5. Washer; 6. Bolt securing drive gear on camshaft; 7. Spacer ring.

Dimension figures for camshaft

- Diameter of camshaft journals: (standard size)	48. 983 - 49. 00 mm
- Undersize 1	48. 733 - 48. 710 mm
- Undersize 2	48. 483 - 48. 500 mm
- Clearance between camshaft journals and bearing bushes:	0. 035 - 0. 107 mm
Limit of wear:	0. 150 mm
- Ovality of camshaft journals: max.	0. 015 mm
- Max. run out of camshaft journals when mounted between centres:	0. 03 mm
- Axial play of camshaft:	0. 111 - 0. 174 mm
- Limit of wear:	0. 300 mm
- Backlash between teeth of distributor drive and driven gear:	0. 049 - 0. 149 mm

- Lift of camshaft cam (without play):

- for inlet valve	6. 850 - 6. 890 mm
limit of wear	6. 600 mm
- for exhaust valve	7. 197 - 7. 237 mm
limit of wear	6. 950 mm
- Clearance between bush-bore and tappet stem:	0. 012 - 0. 054 mm
limit of wear	0. 150 mm
- Diameter of tappet stem:	12. 973 - 12. 988 mm

4. 1. 9. 1. 5. DIMENSION FIGURES FOR CRANKDRIVE

- The crankdrive consists of crankshaft, assembled with piston rods and pistons with piston rings, and the main journals and crank pin bearings.
- The piston in an aluminium alloy casting, assembled with piston rod by the agency of a free piston pin.
- The piston rod, forged of allied steel in an I shape profile, is fitted with a bush at its small end and with two half bearings at its big end.
- The crankshaft is a casting of special high-strenght nodular cast iron.

The long operation time of these components, with relatively ample motions, leads to their wear; their high complexity makes their replacement expensive. For this reason are provided for them repair sizes.

By grinding journals, respectively by rectifying bores, up to determinate sizes, respecting prescribed tolerance zones to obtain prescribed clearances, one will obtain, after engine overhauling, its normal operation.

In the following tables are given dimension figures for piston elements, for piston pin, piston connecting rod and crankshaft, respectively, the allowed number of repairs, corresponding to respective size (see also Fig. 4. 60).

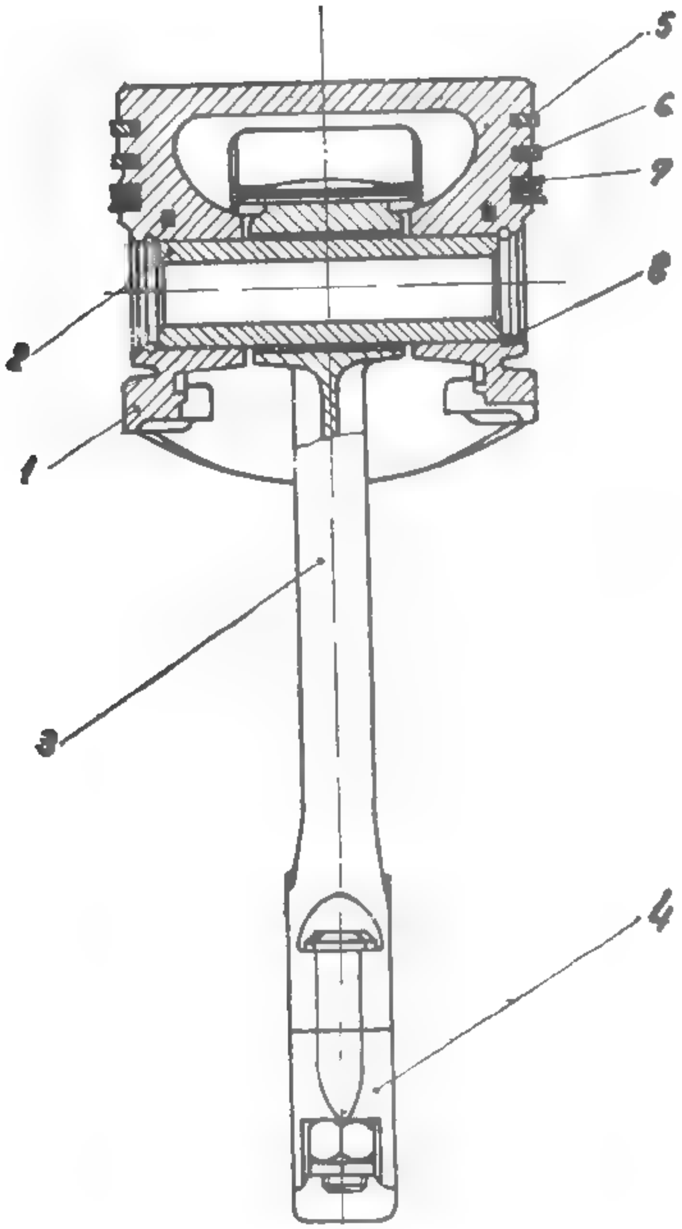


Fig. 4.60. PISTON AND PISTON ROD (ASSY).
1. Piston; 2. Piston pin; 3. Piston rod; 4. Piston rod & bearing cap; 5. Upper compression ring; 6. Lower compression ring; 7. Scraper ring; 8. Snap ring.

Table X

Size	Group A	Group B	Group C
Standard size	96. 926 - 96. 944	96. 944 - 96. 962	96. 962 - 96. 980
Oversize I	97. 426 - 97. 444	97. 444 - 97. 462	97. 462 - 97. 480
Oversize II	97. 926 - 97. 944	97. 944 - 97. 962	97. 962 - 97. 980
Oversize III	98. 426 - 98. 444	98. 444 - 98. 962	98. 962 - 98. 480

The group No. is marked by punching on the piston crown.

Table XI

DIMENSION FIGURES FOR PISTON PIN BORE

Size	Group I (painted red)	Group II (painted white)	Group III (painted black)
Standard size	25. 009 - 25. 006	25. 006 - 25. 003	25. 003 - 25. 000
Oversize I (painted blue)	25. 059 - 25. 056	25. 056 - 25. 053	25. 053 - 25. 050
Oversize II (painted yellow)	25. 109 - 25. 106	25. 106 - 25. 103	25. 103 - 25. 100

The clearance between cylinder bore and piston (on maximal piston diameter - which is ovaly machined) is 0. 056 - 0. 108, with limit of wear 0. 230 mm The clearance between piston and piston pin is 0. 003 - 0. 009, with limit of wear 0. 020 mm,

Table XII

DIMENSION FIGURES FOR PISTON PIN

Size	Group I (painted red)	Group II (painted white)	Group III (painted black)
Standard size	25. 003 - 25. 000	25. 000 - 24. 997	24. 997 - 24. 994
Oversize I (painted blue)	25. 053 - 25. 050	25. 050 - 25. 047	25. 047 - 25. 044
Oversize II (painted yellow)	25. 103 - 25. 100	25. 100 - 25. 097	25. 097 - 25. 094

Piston pin conicity and ovality max. 0. 0003 mm.

Table XIII

DIMENSION FIGURES OF PISTON ROD SMALL-END BUSH BORE

Size	Group I (painted red)	Group II (painted white)	Group III (painted black)
Standard size	25.005 - 25.008	25.002 - 25.005	24.999 - 25.002
Oversize I (painted blue)	25.055 - 25.058	25.052 - 25.055	25.049 - 25.052
Oversize II (painted yellow)	25.105 - 25.108	25.102 - 25.105	25.099 - 25.102

Ovality conicity of small end bush bore max. 0.002, with limit of wear 0.001 mm.

STANDARD DIMENSION OF PISTON ROD

- Bore diameter for mounting half-bearings, after having tightened bolts with 6 - 7 m.daN (43.5 - 50.5 ft.lbs) torque:	50.50 - 50 52 mm
- Ovality conicity of bigend bore, after having tightened it as above:	0.010 mm
- Twist flexure of piston rod, i.e. max. allowed deviation from parallel coplanar alignment of small big-end bore axis:	0.05/100 mm
- Axial play between piston rod and crankpin collar:	0.125 - 0.300 mm
Limit of wear:	0.375 mm
- Clearance between small-end bush and piston pin:	0.002 - 0.008 mm
Limit of wear:	0.020 mm

Table XIV

DIMENSION FIGURES OF PISTON RINGS (in mm)

S i z e	Standard size	Oversize I	Oversize II	Oversize III
Outer diameter of upper compression ring, when compressed with a force of 8 kg (17. 5 lbs)	97	97. 5	98. 0	98. 5
Outer diameter of lower compression ring, when compressed with a force of 9. 5 kg (21 lbs)	97	97. 5	98. 0	98. 5

- Height of compression rings:	2. 478 - 2. 490
- Height of oil scraper ring assembly:	4. 480 - 4. 960
- Side clearance of compression rings in piston grooves	0. 050 - 0. 102
Limit of wear:	0. 163
- Side clearance of scraper rings assembly in piston grooves:	0. 080 - 0. 240
Limit of wear:	0. 300
- Width of upper compression ring gap:	0. 400 - 0. 550
Limit of wear:	1. 500
- Width of lower compression ring gap:	0. 400 - 0. 600
Limit of wear:	2. 500

DIMENSION FIGURES OF THE CRANKSHAFT (ASSEMBLY) (in mm)

- Radial run out of journals with crankshaft seated on the two end journals: (max. all).	0. 040
- Deviation from regular cylindrical form of journals and crankpin surfaces:	0. 012 max. allowed
- Limit of wear being:	0. 025
- Lenght of middle journal (Standard size)	34. 075 - 34. 125
- Length of crankpin: (Standard size)	25. 050 - 25. 150

- Lateral run out of middle journal side-faces, with crankshaft seated on the two end journals: (max. allowed)	0. 025 at the extremes
- Axial play of crankshaft:	0. 075 - 0. 125 with
Limit of wear:	0. 180
- Lateral of distribution gear, when mounted on crankshaft: max.	0. 10 per radius of 35 mm
- Diameter of distribution drive gear journals:	36. 002 - 36. 028
- The diameters of journals and crankpins are indicated in the Table XV	
- Ovality and conicity of the main half-bearing bore, when tightened as above mentioned:	0. 20 mm max.
- Radial play between journal & its half-bearing:	
- For journals No. 1 - 4;	0. 058 - 0, 124
with limit of wear	0. 180
- For journal No. 5:	0. 018 - 0. 085
with limit of wear	0. 160
-For middle bearing (No. 3), the play should be:	0. 040 - 098
with limit of wear:	0. 160

- Bore diameters of big-end half-bearings, when bolts are tightened with a torque of 15. 4 - 16. 8 m. daN (111 - 121 ft. lbs) on main bearing caps and 6 - 7 m. daN (43. 4 - 50. 7 ft. lbs) on big-end bearing caps, are indicated in the Table XV.

Table XV

DIAMETERS OF CRANKSHAFT MAIN JOURNALS, CRANK PINS, MAIN BEARINGS AND BIG-END BEARINGS

(Both main & big-end bearings being tightened as above indicated)

Size	Diameter of main journals	Diameter of crank pins	Diameter of journals half-bearing bore	Diameter of big-end half-bearing bore
Standard	65.000 - 65.020 x)	56.980 - 57.000	65.058-65.104	57.075-57.036
Unders. 1	64.730 - 64.750	56.730 - 56.750	64.808-64.854	56.826-56.786
Unders. 2	64.480 - 64.500	56.480 - 56.500	64.558-64.604	56.576-56.536
Unders. 3	64.230 - 64.250	56.230 - 56.250	64.308-64.354	56.326-56.286
Unders. 4	63.980 - 64.000	55.980 - 56.000	64.058-64.104	56.076-56.036
Unders. 5	63.480 - 63.500	55.480 - 55.500	63.558-63.604	56.576-55.536
Unders. 6	62.980 - 63.000	54.980 - 55.000	63.058-63.104	55.076-55.036

x) For the main journals No. 5 (counting from the cooling fan), the standard size is: 65.020 - 65.040.

- Max. lateral run out of flywheel working surface (when assembled with crankshaft), measured at extremities: 0.250 mm
- Max. allowed clutch imbalance (on static balancing, unassembled with crankshaft): 30 cm.g

4.1.9.2. DISMANTLING REMEDYING CYLINDER BLOCK COMPONENTS

After taking engine down from vehicle (Op. 2.0.10.01.0) and taking gear box down from engine (Op. 2.1.10.01.1), set and fasten engine in D 5 special, rotating device, which allows engine rotating in different position, optimal for dismantling its units and components.

- Firstly take down external components from cylinder block (see Op. 4.1.10.01.3).
- Take down and remedy the clutch.
- Take down and remedy the crankshaft.
- Take down and remedy the camshaft.
- Perform remedying of cylinder block and cylinder liners.

1.9.3. REMEDYING OPERATIONS

OP. 2.0.10.01.0 TAKING ENGINE DOWN FROM VEHICLE

- Drain cooling, system, acc. to Op. 2.0.13.04.0.
- Drain lubricating system, acc. to Op. 1.0.01.03.0.
- Disconnect and removed expansion vessel, if engine is provided with sealed cooling system, acc. to Op. 2.0.13.06.1.
- Disconnect water pump from heating system and from cooling radiator. Slacken alternator holding bracket and remove its driving V-belt.
- Unscrew bolts fastening fan cowling and pass the latter over the cooling fan.
- Disconnect cylinder head cover from air cleaner, undoing connecting hose from cover connecting piece.
- Disconnect carburettor from air inlet hose, removing it from carburettor adapter.
- Disconnect carburettor from acceleration & choke control linkages.
- Take down transmission tunnel cover, acc. to Op. 2.0.53.01.0.
- Dismantle engine electric equipment, disconnecting leads to alternator, ignition distributor, starting motor, ground lead and back-up switch.
- Disconnect heating system from cylinder head.
- Disconnect flexible speedometer shaft from transfer box.
- Disconnect muffler fore pipe from exhaust manifolds.
- Disconnect fuel pump from connecting pipe with the fuel tank.
- Disconnect clutch slave cylinder from flexible hydraulic pipe.
- Dismantle and take down both, front and rear propeller shafts, from transfer box.
- Unscrew bolts fastening the engine on the chassis frame, after having removed securing split pins.
- Catch and lift engine by means of D 105 lifting device and set engine on a support, or, better, on special D 5 rotating device.
- After having performed all necessary remedyings, refit engine in reverse order to that on dismantling, tightening all bolts with the torque indicated in Table XVI.
- Refill engine with adequate fresh oil and crank the engine 2 - 3 turns, in order to put in operation its lubricating system (see Op. 1.0.01.03.0).
- Refill cooling system with adequate cooling fluid, acc. to Op. 2.0.13.19.0 Check both systems for leakages.

OP. 3.1.10.01.1. TAKING GEARBOX DOWN WHEN ENGINE IS TAKEN DOWN FROM VEHICLE

- Using a strap and crane or a lifter of 100 daN (220-230 llb) force, sustain the gearbox assembled with transfer box without forcing their position relatively to engine.
- Remove clutch (release) fork, releasing so throwout sleeve, which will get out together with the gearbox.
- Unscrew bolts fastening gearbox on the cluth housing.
- Draw out axialy the gearbox, so that transmission shaft gets out from the clutch hub splines.

  On refitting gearbox, perform operation in reverse order, tightening nuts with a torque of 3 - 4 m. daN (22 - 29 ft.lbs).

  Before taking down gearbox and transfer box it is useful to drain oil from both of them and after refitting to refill them with fresh adequate oil.

OP. TAKING CLUTCH HOUSING DOWN

- This this operation only if strictly necessary:
- Take starting motor down from engine.
- Unscrew bolts fastening cluth housing on cylinder block, after having previously finely marked mutual position of the two components (The marking is a suplimentary precaution, because the alignment of cluth housing on the block is provided with dowel pins.).

  On refitting cluth housing on engine block tughten bolts with a torque of 6.5 - 7.5 m.daN (47 - 54 ft.lbs).
- Check distance between starting motor and crankshaft main bearing axis.

OP. 3.1.10.04.0. TAKING CYLINDER HEAD DOWN FROM ENGINE, WHEN IT IS TAKEN DOWN FROM VEHICLE

- Remove H.T. ignition leads and the spark plugs.
- Remove exhaust manifolds.

Undo connections of noses between thermostat elbow and water pump, respectively between thermostat elbow and inlet manifold and cylinder head.

- Undo connection between fuel pump anc carburattor.
- Take down inlet manifold with carburettor mounted on it.
- Remove thenmostat elbow.
- Remove cylinder head cover.
- Remove the cooling fan.
- Unscrew bolts fastening cylinder head on engine block, removing then cylinder head ant its gasket.

  On refitting perform the operations in reverse order, with the remark that. the cylinder head fastening bolts should by tightened as indicated in the Op. 2.0.01.17.0 and Fig.1.24.)

OP.3.1.10.05.0. TAKING WATER PUMP DOWN, WHEN ENGINE IS TAKEN DOWN FROM VEHICLE

- Disconnect water pump from the hose connecting it with the thermostat elbow.
- Unscrew bolts fastening water pump on cylinder block and remove the pump together with its gasket.

  On refitting the pump perform the operations in reverse order.
- Tighten the bolts with a torque of 3.5 - 4.5 mdaN (25 - 32.5 ft.lbs)

OP. 3.1.10.01.3. TAKING DOWN EXTERNAL COMPONENTS FROM ENGINE BLOCK

- Take alternator down, acc. to Op.2.0.37.06.1.
- Take starting motor down, acc.to.Op.2.0.37.17.0.
- Take gearbox down, acc.to Op.2.1.10.01.1.
- Take water pump down, acc.to Op.4.1.10.05.0.
- Take cylinder head down, acc.to Op. 4.1.10.05.0.
- Take down oil pump (remember special screw position), and remove it together with its gasket.

- Remove strainer housing assembly.
- Take fuel pump down, acc. to Op. 2.0.01.27.0.
- Take ignition distributor down.
- Take oil pump down, acc. to Op. 2.0.01.33.0.
- Draw out oil dip stick.
- Take oil filter down, inclusively filter box seat with its gasket, acc. to Op. 2.0.01.11.0, respectively Op. 2.0.09.05.0.
- Remove manometric transmitter, oil pressure alert transmitter, water temperature alert transmitter.
- Unscrew starting ratchet by means of D 13 device.
- Draw out cranskshaft pulley by means of D 14 extractor.
- Take down timing gear cover, together with engine fore bracket and timing pointer, after having prior marked special screws position.

  On refitting perform the operations in reverse order, tightening bolts with the torques indicated in the Table XVI.

OP.3.1.10.06.0. TAKING COMPONENTS DOWN FROM ENGINE, WHEN CRANKDRIVE IS TO BE REMEDIED

- Slacken alternator BV-belt tensioner, tilt alternator and remove V-belt.
- Take gearbox down, acc. to Op. 2.1.10.01.1.
- Take cylinder head down, acc. to Op. 4.1.10.04.0.
- Take oil sump down (remember special screw position) and remove its gasket.
- Unscrew starting ratchet, by means of D 13 device.
- Draw ot crankshaft pulley by means of D 14 extractor.
- Take down timing gear cover, together with engine fore bracket and timing pointer, after having marked the position of special bolts.

  On refitting perform the operations in reverse order and tighten all bolts with the torques indicated in the Table XVI.

OP. 4.1.04.02.1. REPLACING PISTONS ON ARO L-25 ENGINES

- Take cylinder head down, acc.to Op. 4.1.10.04.0.
- Take oil sump down and remove its gasket (remember special bolt position)
- Turn the cranskshaft by means of D 18 cranking device, until the piston rod bearing caps of cylinders 1 and 4 reach their outer position (outer dead centre) (see Fig.4.61).

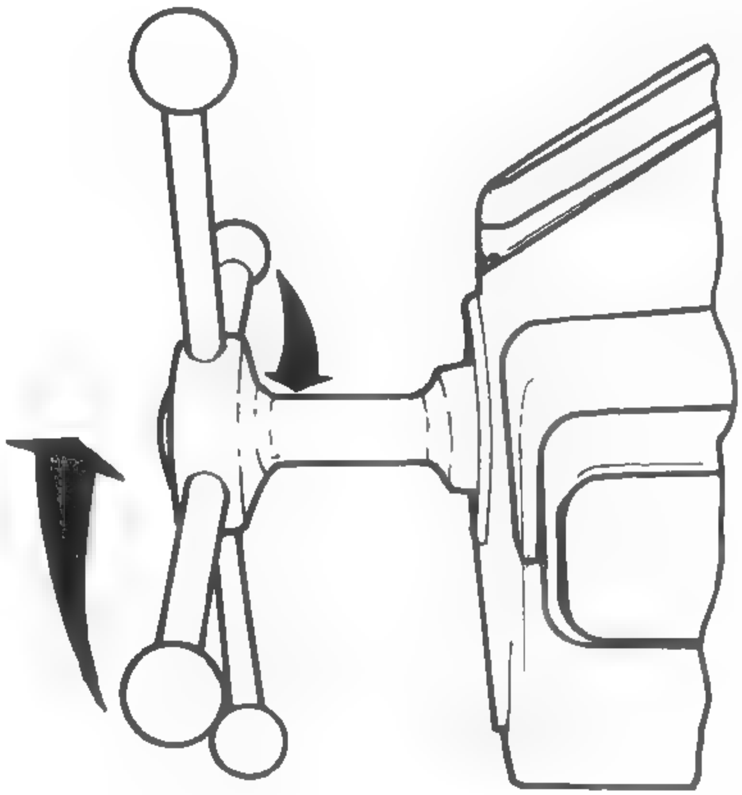


Fig.4.61. TURNING ROUND CRANKSHAFT BY MEANS OF D-18 DEVICE.

- Unscrew fastening bolts and remove respective bearing caps of 1 and 4 cylinder piston rods. Remember position of bearing caps.
- Now, using a wooden rod, blow on piston bottoms, pushing them up to inner dead centre. During this operation hold always piston rod in order

to avoid its bolts to scratch the surface of crank pins and cylinders. Push pistons further, untill they get out from cylinder block.

- Now fit back the bearing caps (especting their right position) and screw provisionally nuts, tightening them (only by hand.)
- Turn crankshaft with 180^{0} and perform the same operations with the pistons 2 and 3.
- Remove piston pin snap ring and press piston pin out. Remove it and the piston rod.
- Remove piston rings, using S 11 pliers.
- Select new pistons, depending on cylinder liner rate of wear, acc. to indications given in Op. 4.1.04.02.0.
- Assemble new pistons with piston rods and fit them back in the engine block acc. to St. 4.1.04.02.2 and 4.1.04.02.3. (St. = Stage).

ST.4.1.02.02.2. ASSEMBLING PISTON WITH PISTON RINGS AND PISTON ROD

On assembling piston and piston rod take care to ensure correct position of oil splash holes in piston rod, in keeping with the mark milled on edge of piston top. The splash hole situated in inner part of piston rod I section should be on opposite side of milled mark on piston.

- Introduce piston pin in piston, painted end first, after having firstly wiped and then smeared with oil, pin, bores of piston and small-end bush.
- Secure piston pin by introducing snap rings by means of S 10 pliers.
- Check by hand that the piston rod swings easily and without any play on piston pin.
- Fit piston rings in the following order:
  - Fit expansion ring in respective groove and set its ends true.
  - Fit first scraper ring by hand on lower side of expansion ring.
  - Fit second scraper ring on upper side of expansion ring. Scraper and expansion rings should be able to be turned by hand in their piston groove.
  - Fit the compression rings by means of S 11 pliers (see Fig. 4.62).

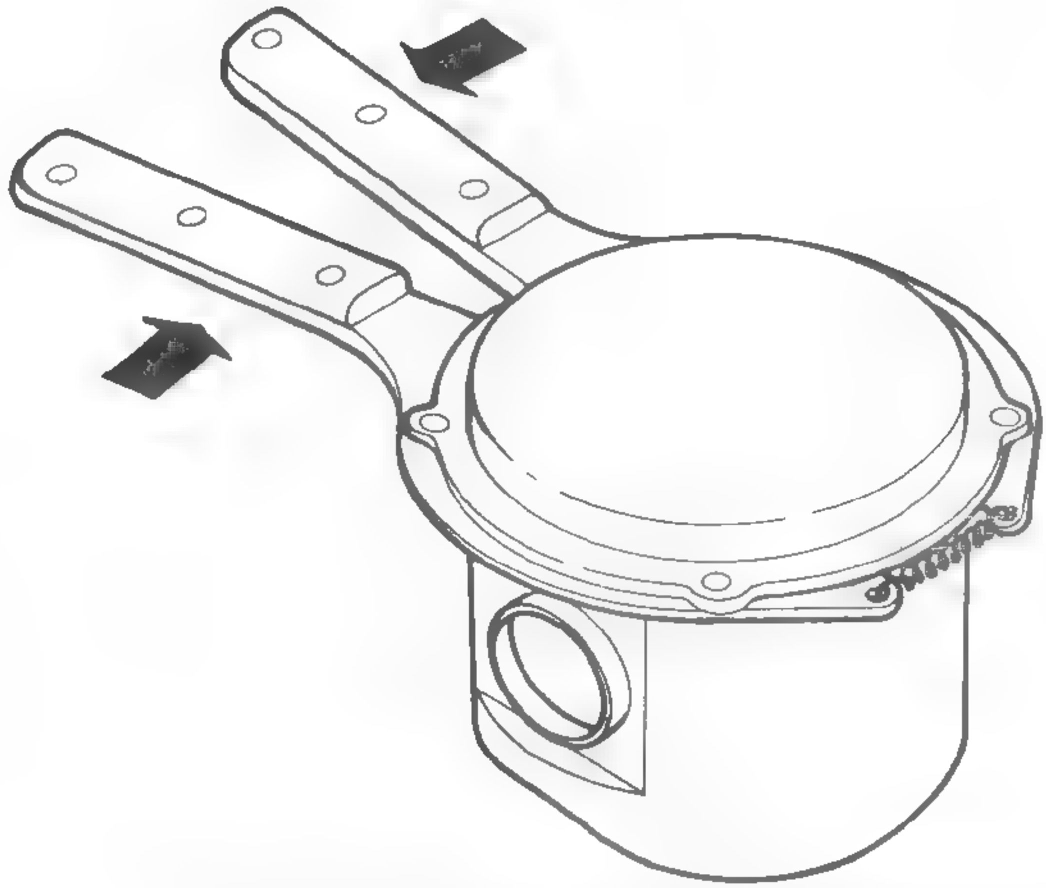


Fig. 4. 62. FITTING PISTON RINGS BY MEANS OF S-11 PLIERS

- Fit lower compression ring in S 11 pliers and then fit it in the middle groove, taking care that fluting in ring should face upwards.
- Fit upper compression ring, with marked face upwards, in upper groove.

IMPORTANT: If rings do not fit in grooves, replace them by others. In no case should they be trued up !

- Check side clearance of compression rings by means of S 12 feeler gauge. The feeler gauge should glide freely all round, without jamming. By the wear, on the lateral face of the piston groove is building a step. If these steps are high the piston should be replaced by a new one, of necessary size.

ST. 4.1.04.02.3. REFITTING PISTONS IN THE ENGINE BLOCK

- Set the cylinder block on its side, with cylinder bore axes horizontal.
- Unscrew the nuts and remove big end bearing cap & half-bearing.
- Pass piston rod and piston skirt through S 17 assembling sleeve, and then through respective cylinder (see Fig.4.63), taking care to not scratch with big-end bolts the cylinder liner and crank pin surfaces. The mark on the piston top should face the timing gear cover.
- Pour oil on piston rings, which should be previously set with their gaps at 120°
- Turn crankshaft till the crank pin of respective cylinder reaches its inner dead centre.
- Using a wooden rod or a hammer tail, push the piston through S 17 mounting sleeve, (whose conicity, presses piston rings inwards and allows them to enter the cylinder liner), untill big-end bearing contacts crank pin. Smear crank pin with graphite or molycote oil.
- Fit on crankpin respective (prior marked) half-bearing and its cap and screw the two nuts some turns. Take care that serial number of the bearing cap faces that on the piston rod.
- Turn crankshaft with 180° so that big-end bearing cap reaches outer dead centre. Tighten nuts of bearing cap with a torque of 6 - 7 m.daN (43 - 51 ft.lbs.).

NOTE: In order to facilitate piston penetrating into cylinder liner, smear previously the piston with fresh engine oil.

OP. 4.1.04.02.0. CRANKDRIVE COMPLEX REMEDYING

- Take cylinder head down, acc. to Op.4.1.10.04.0.
- Take oil sump down and perform further operation according ot Op. 4.1.04.02.1, above described.

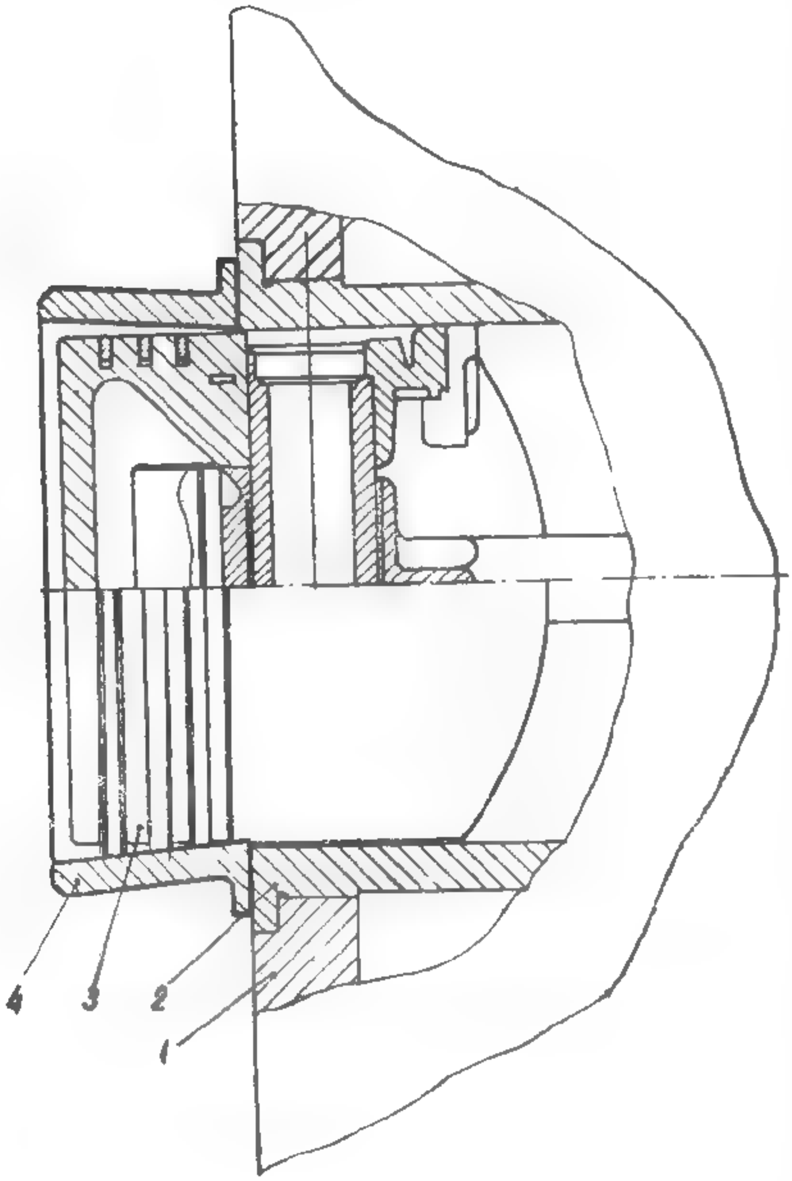


Fig. 4.63. FITTING PISTON & PISTON ROD ASSEMBLY IN CYLINDER BLOCK BY MEANS OF S-17 ASSEMBLING SLEEVE:

1- Cylinder block; 2- Cylinder liner; 3- Piston & piston rings assy; 4- S-17 assembling sleeve.

CLEANING & CHECKING OF PISTON RODS

- Before cleaning piston rods, remove half-bearings from piston big end and bearing cap. In case these are to be of further use, mark them so as to mount them in their places.
- Wash piston rod body, big & small end bores Avoid using caustic solutions. Blow out oil ducts with compressed air.
- Check ovality and conicity of bores for the mounting of big-end half-bearings. This checking should be done after monting bearing cap on piston rod body and tightening bolts with a torque of 6 - 7 m.daN (- 52 ft.lbs). Ovality & conicity of bore should not exceed 0.01 mm. If this limit is exceeded, the piston o rod should be replaced with a new one.
- Check piston rods for fissures, cracks or fracture set off. If any such faults are found, replace the faulty piston rod.
- Check clearance between piston pin and small-end bush. The clearance should be within above indicated limits. If limit of wear is exceeded, ream or lap bush for an oversize piston pin. If last oversize is surpassed, replace the bush by a new one.
- New bush should be reamed after being pressed in
- Check distance between small and big-end bore which should be of 161.9 - 162 mm.
- Inspect with care bolts and nuts of piston rods. If any are faulty, replace them.
- Check by means of V 6 checker if axes of small & big-end bores are coplanar and parallel (see Fig. 4.64). If deviation caused by twist or flexure exceeds the priorly indicated limits, the piston rod should be straightened, or, if not possible, replaced.

b) CLEANING & CHECKING PISTONS (Fig. 4.64).

- Scour carbon deposit from off outside and inside of piston head, using a solvent without alkalies and a fine wire brush.

IMPORTANT: Remember that any caustic, alkaline solution strongly attacks aluminium and its alloys.

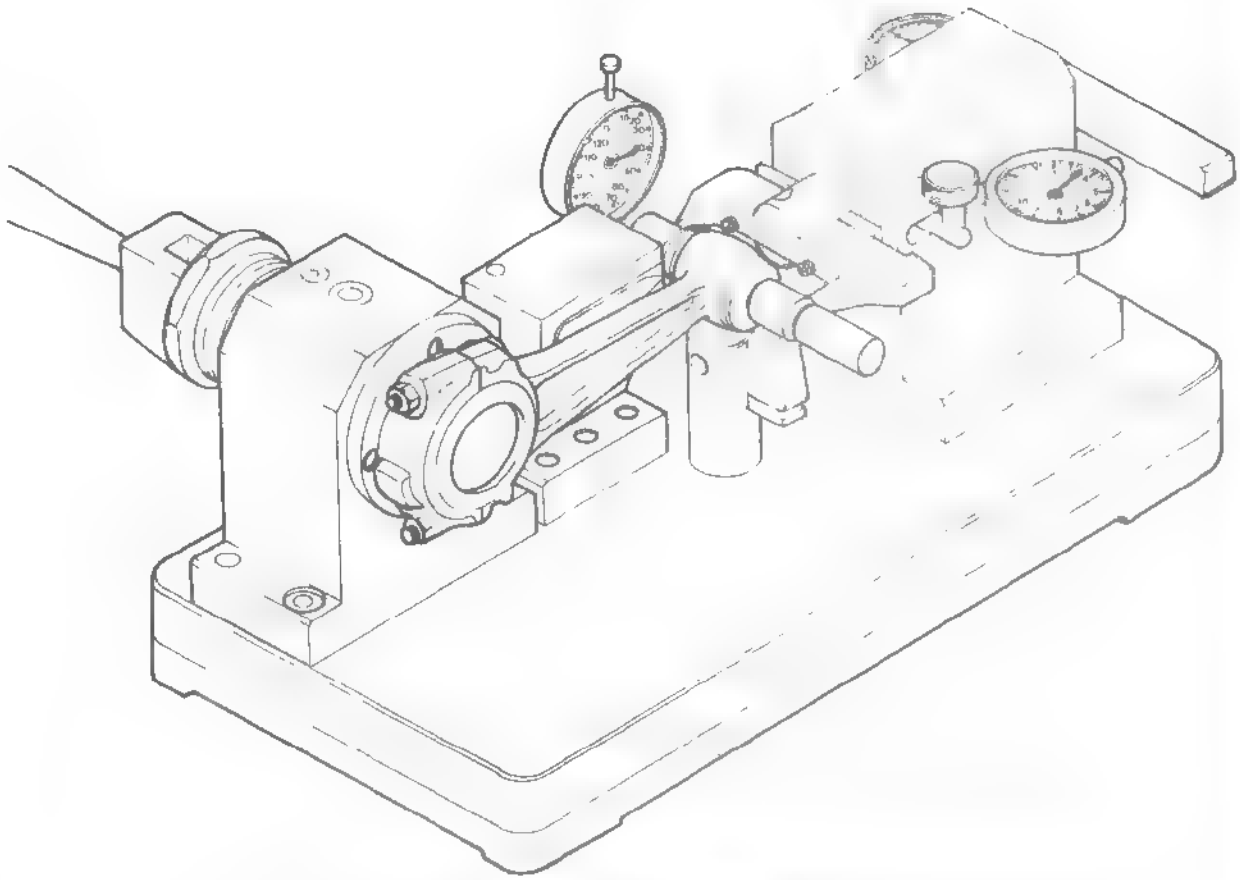


Fig. 4.64. CHECKING TWIST, FLEXURE AND LENGTH OF PISTON ROD BY MEANS OF V-6 CHECKER.

- Clean piston grooves from carbon deposit by means of special 9 device as showen in Fig. 4.65.
- Clean Oil ducts & oil holes. Inspect piston grooves for ridges. If ridges are present, replace pistons, as the former prevent correct operation of piston rings and lead to an excessive lateral play. On replacing pistons take account of piston group and colour.
- Inspect pistons for chips between grooves, on skirts and on piston pin bosses. Check if no scorings and signs of seizing are prezent on piston skirt.
- Replace pistons giving signs of excessive wear, waviness between grooves, chips, spongioness or erosions at top rim of piston, caused by surface ignition or knocks in combustion chamber.
- Check clearance between piston pin and piston bore, by dismantling and measuring both dimensions. Piston pins with scores, excessive wear or

fissures should be replaced. Check also piston pins for corrosions and chips; replace faulty piston pins.

Check gap of piston rings. When overhauling the engine, it is advisable to change the whole piston ring set. Never change piston rings from one piston to another, whatever the number of kilometres covered the vehicle.

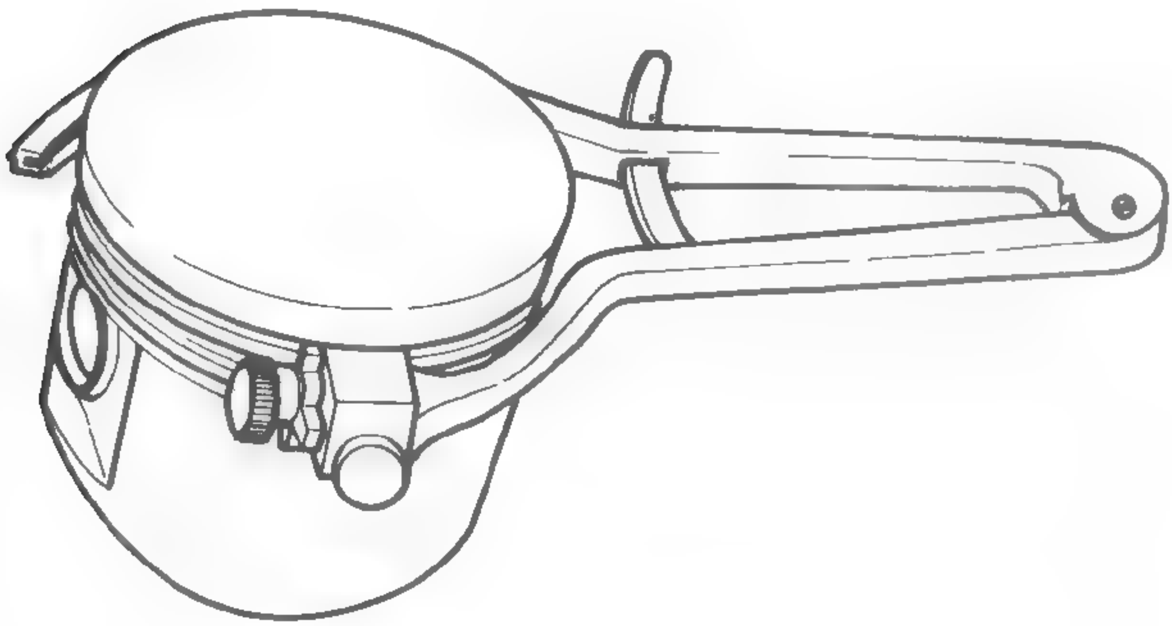


Fig. 4.65. REMOVING CARBON DEPOSIT FROM PISTON RING GROOVES BY MEANS OF S-9 DEVICE;

- In case that it is necessary to fit new piston rings, without processing cylinder liners, remove the lustre of liner bore by very short grinding or honing using very fine abrasive stone. Do not grind more than necessary to complete removing of lustre.
- After grinding or honing wash thoroughly the walls of cylinder liners and cylinder block, in order to remove any traces of grit on working surfaces. Then, smear liner bore with engine oil.
- Do likewise on dismantling other piston & piston rod assemblies.

c) MARCHING PISTONS & PISTON RODS

For engine repairs pistons are manufactured in three oversizes, having increased outer diameter. Standard size and all three oversize pistons are sorted in three groups, marked A, B, C, These letters, stamped on piston tip, represent three groups of dimension figures.

Pistons marked A, B, or C, whether standard - or oversize, should be mated only with cylinder liners having standard or undersize bores, belonging to the same sorting group. These bore sizes are different, according to repair step and to the group A, B or C of each repair step. Consequently, an oversize No. 1 piston, belonging to group A, should be mated only with an undersize No.1 cylinder liner, belonging to the same group A.

Only thus will the claerance between maximal piston body diameter and cylinder bore be within prescribed limits.

Besides above conditions relating to size, one should also respect conditions imposed by weight. Whatever the size or sorting group, one should only mount pistons belonging to the same weight group on same engine. The weight group is marked by one of the figures 1 - 7, stamped on piston top.

The piston rods which will be assembled to pistons selected as above should have the smal-end bush bore which must tally with the piston pin bore, i.e. they must be marked with same colour and have same oversize number.

All piston rods, mounted on same engine, must have same weight, i.e. must belong to same sorting group.

Having satisfied the above conditions one can begin fitting the pistons. Namely:

- Check clearance between max. diameter of piston body, measured with a micrometer snap gauge, and of cylinder linear bore, measured with an inside dial gauge, set to a ring calibre. The clearance should be within the limits of 0.056 - 0.092 mm. The limit of wear is 0.230 mm. If limit of wear is exceeded, the cylinder liner should be reamed up to the following oversize dimension and the piston replaced with new piston, having corresponding oversize

- Ream cylinder liner also if mesurements indicate an ovality exceeding o.125 mm or taper exceeding 0.200 mm.
- After reaming, check the resulting dimension figure and a piston corresponding as size to new diameter of liner bore, without losing sight that the piston must belong to the same weight group as the other pistons.
- Measure both cylinder liner and piston at ambient temperature.
- Once fitted, mark piston top with the oversize number, using figures 5 mm high.

To check piston ring gap proceed as follows:

- Remove piston ring of piston and introduce it in cylinder to which it pertains. Push ring till it descends beneath ledge formed by wear. To set the piston ring correctly, push it in with piston, having its rings removed.
- The ring gap should be within the limits of 0.35 - 0.55 mm. The limit of wear is 1.5 mm for upper compression ring, and 2.5 mm for lower compression ring. Piston rings having gaps exceeding limit of wear should be replaced.
- For each oversize piston and cylinder bore, corresponding piston ring sets are manufactured.

  It is necessary to check gap of piston rings which are to be mounted, even if cylinder liner bore has been ground to corresponding oversize dimension of piston and piston rings.
- If gaps of piston rings, checked as shown above, are smaller than specified lower limit, they should not be mounted but should be replaced by another set, having necessary gap. Too small a gap may lead to the blocking of rings through dilatation and seizing on cylinder bore.
- Check piston rings also for side clearance in piston grooves.

d) FITTING PISTON PINS

Piston pins are manufactured in standard - and oversizes. Each of these are sorted out in three groups, painted in different colours (red, white black). The purpose of these colour-markings is to facilitate mating of piston pin with piston and small-end bush bores, i.e. if an oversize No. 1 piston with bore for piston pin painted red is fitted together with an oversize

No.1 piston rod, one should select a No.1 oversize piston pin pained red. Only thus may correct clearances be obtained, between piston pin and piston (0.003 - 0.009) and between piston pin and small-end bush (0.002-0.008 mm).

- Knowing that, pass on to operation of fitting piston pins, on occasion of engine overhauling.
- Check, by measuring, existing clearance between piston and piston pin, between piston pin and small-end bush, as well as ovality and taper of piston pin.
- In case that wear exceeds maximal allowed limit, replace piston pin by next oversize (if neither piston nor piston rod are to be replaced). On replacing piston pin, both bore of piston and small-end bush should be reamed, in order to mate with new oversize pin. The small-end bush can also be trued by lapping.
- To ream bore in piston (for piston pin) use an expandible reamer and a guiding sleeve. In order to maintain coaxiality of both bore halves and perpendicularity of bore to piston generatrix, ream firstly one bore-half with reamer guided by guiding sleeve, introduced in second bore-half. Expand reamer till required dimension figure is obtained. Ream carefully, with much fineness, removing each time only a slight stook. Repeat reaming both half-bores checking each time dimension of bore with new piston pin. Bore should be checked with dial indicator set to a ring gauge.
- Ream or lap samll-end bush to fit respective oversize piston pin with specified clearance.

e) FITTING PISTON RODS ON CRANK PINS

To ensure a correct clearance between piston rod big-end bearings and crank pins, mount again big-end half-bearings, over them the bearing caps and tighten bolts with a torque of 6 - 7 m.daN (43 - 50.5 ft.lbs.).

- Measure bore of big-end bearing with inner dial gauge set to a ring gauge.
- Measure crank pin diameter with a micrometer caliper (or indicating snap gauge), checking also deviation from regular cylindrical form of crank pin, which should not exceed 0.025 mm.

- Then check if the resulting clearance between crank pin and bearing is within prescribed limits.

  In this manner check all four crank pins and big end-bearings.

  The prescribed clearance between big-end half-bearings and crank pins should be within limits of 0.044...0.104 mm, with a limit of wear of 0.180 mm.
- If clearance exceeds above specified limits, or deviation from regular cylindrical form exceeds 0.025 mm (for one or several crank pins), replace respective big-end bearings with succeding undersize, measure resulted bearing bore (with bolts tightened as above) and true up (by grinding) respective crank pins up to corresponding undersize, taking in account the bore size of replaced bearings and the above prescribed clearances.
- Check running surface of big-end half-beraings for: scratches or impurities imbedded in the friction surface of bearing; signs of seizing or scorings, due to deficiency of lubrication; polished areas, due to an untrue setting; signs of overlapping of material or blisters, due to fatigue.

OP. CHECKING PISTON RING GAPS AND LATERAL PLAY IN PISTON GROOVES

- Remove the checked piston ring from off the piston, using special S 11 pliers and introduce it into cylinder to which it pertains. Push piston ring, with a piston without rings, till it descends beneath ledge formed by liner wear.
- The ring gap should be within the limits of 0.35 ... 0.55 mm, with limit of wear of 1.5 mm for upper - and of 2.5 mm for lower compression rings. Piston rings having gaps exceeding limit of wear should be replaced. For each oversize piston and for each eversaize cylinder bore respectively, corresponding ring sets are manufactured.
- On replacing a piston ring check its gap, after introducing it into respective cylinder and if the gap is below the lower indicated limit replace it by another set. Too small gap may lead to the blocking of rings through dilatation, causing seizing on cylinder liner.

- After fitiing rings on respective piston, check them for side clearance in the piston grooves.
- The expansion and scraper rings should be able to rotate easily by hand in their grooves. Check their side clearance by means of a feeler gauge of 0.05 mm.
- It is not allowed that a rings gets jammed in its groove.
- Never adjust by grinding a ring in order to make it enter the groove. It may damage gravely the cylinder liner surface.

OP. 4.1.05.01.0. TAKING CRANKSHAFT DOWN FROM ENGINE BLOCK

- Take engine down from vehicle, acc. Op.2.0.10.01.0.
- Take down gearbox assembled with transfer box, acc. to.Op.2.1.10.01.1.
- Take down cylinder head assy, acc.to. Op.3.1.10.04.0.
- Take down components from engine block, acc. to Op.3.1.10.06.0.
- Take down pistons, acc.to Op.4.1.04.02.1.
- Unscrew and remove starting ratchet, by means of D 23 device.
- Draw out crankshaft pulley, by means of D 14 extractor.
- Remove timing gear cover together with engine fore bracket and timing pointer.
- Remove timing gear cover gasket, oil slinger and the pulley key.
- Remove cluth housing cover.
- Remove rear bearing sealing cover, proceeding as follows:
  - Unscrew bolts which fasten rear bearing sealing cover and then remove sealing cover by slight lateral taps. On mounting, the cover was sealed with wooden wedges, presed into cover lateral grooves, so that it can happen that the cover should be forced on dismantling. Take special care to not damage the sealing surface or the components' shape.
  - On refitiing rear bearing cover use new wooden wedges.
- Remove main bearing caps, together with respective main half-bearings. Now, the crankshaft is free and can be lifted together with the clutch.

- For balancing crankshaft on lifting, the textile strap should be passed under crank pin No. 4.

  REMARK: The crankshaft should be handled with special care so as to avoid impairment of its finished surfaces of main journals and crank pins.

- After removing crankshaft set bearing caps and half bearinge in order and in the same position as the one in which they have been working, so as to be able to measure them.

OP. 2.1.05.02.0. DISMANTLING & CLEANING CRANKSHAFT

- Perform all necessary operation for crankshaft taking down, as above described.
- Set crankshaft on a smooth support, setting main journals on smooth, non metallic material.
- Draw out distribution drive gear, using D 15 extractor. Do this only if gear replacing in necessary (On pressing it back use S 13 pressing device.)
- Unscrew bolts fastening cluth on flywheel.
- Remove clutch and clutch disc assy.
- Unscrew bolts fastening flywheel on crankshaft and remove flywheel. Remove flywheel only of its replacing or reconditioning are necessary.
- Clean and wasn crankshaft using an adequate solvent. Then clear all oil ports by blasting them with compressed air.
- Check if running surfaces have any scratches, scorings, fissures or traces of seizing. The smaller flaws can be touched up with a very fine grained hone. Bigger flaws can be removed only by grinding faulty surfaces.
- Inspect rate of wear of journals and crank pins.
- Measure diameter of each running surface and check deviation to regular cylindrical form which should not exceed 0.025 mm. If deviation exceeds limit of wear the journal or crank pin should be trueo up by grinding. The trueing up can be carried out on one, several or all journals and crank pins, where limit of wear is exceeded. On trueing up remove only the stoock strictly necessary to ensure correct clearance between journal/crank pin and undersize bearing.

If journal or crank pin can not be trued up to specifications of last undersize No.,, the crankshaft should be replaced.

On trueing up the middle journal, pay attention to oversize length, so as to maintain axial clearance of crankshaft in prescribed limits.

- Likewise respect fillet radius between web and journal/crank pin. For this, dress the hone used for trueing with same radius as the initial one. Too small a radius leads to an undue stress of the crankshaft, whereas too large a radius stresses the bearing.
- Chamfer edges of oil holes after trueing up hjournals/crank pins.
- Super-finish trued up surfaces.

REMARK: Wash the crankshaft with great care after above processings so as to remove any trace of abrasive from oil ports.

On refitting crankshaft take account of the following operations:

- Fit flywheel on crankshaft.
- Mount bolts and lock-plates securing flywhell to crankshaft.
- Tighten bolts successively with a torque of 5 - 5.7 m.daN (36 - 41 ft.lbs.) Lock bolts by bending edges of lock-plates.
- Wipe assembled clutch disc with a cloth and set it on flywheel. Center disc by means of D 4 splined centering drift.
- Superpose the clutch, with care as to the position of zero mark for balancing on flywheel and crankshaft.
- Screw bolts securing cluth and tighten them with a torque of 2.5-3.5 m.daN (18 - 25 ft.lbs.).
- Remove centering drift.

REMARK: In case that crankshaft, flywheel or cluth have been replaced, the complete crankshaft assy should be dynamically balanced. Max.allowable imbalance is 70 gr.cm.

OP. 4.1.05.03.0. TAKING FLYWHEEL DOWN FROM CRANKSHAFT

- Take engine down from vehicle, acc. to Op. 2.0.10.01.0.
- Take down gearbox assembled with transfer box, acc. to Op.2.1.10.01.1.
- [illegible] starting motor down.

- Take clutch housing cover down.
- Mark mutual position and take down clutch housing.
- Mark mutual position between clutch and flywheel and take down the clutch.
- Unscrew bolts and the flywheel down from crankshaft.
- On refitting flywheel perform operations in reverse order, tightening bolts with the torque indicated in the Table XVI.

OP. 2.1.05.02.1. REPLACING FLYWHEEL RING GEAR

- Take engine down from vehicle, as described in Op. 2.0.20.01.0.
- Take gearbox assembled with transfer box, down from engine, acc. to Op. 2.1.10.01.1.
- Take flywheel down, acc. to Op. 4.1.05.03.0.
- Using an abrasive blade, out the flywheel ring gear but without touching the flywheel. The last 2-3 mm will give up if the made out is forced by means of a chisel.
- Clean assembling surface on the flywheel.
- Heat ring gear up to about 180°C temperature, in order to increase its inner diameter.
- By means of a hydraulic press press the warm ring gear on the flywheel, paying attention to keep ring gear parallel to flywheel friction surface.
- After pressing, refitt flywheel on the crankshaft in reverse order, tightening bolts with the torque indicated in the Table XVI and securing bolts by bending edges of the lock plates.

OP. 4.1.05.03.1. TAKING DOWN & REPLACING THE FLYWHEEL RING GEAR WHEN CRANKSHAFT IS TAKEN DOWN FROM ENGINE

- Take engine down from vehicle (Op. 2.0.10.01.0.).
- Take gearbox & transferbox assy down from engine (Op. 2.1.10.01.1.).
- Take cylinder head down from engine (Op. 3.1.10.01.0).
- Remove pistons from engine (Op. 4.1.04.02.1).
- Take crankshaft down from engine, acc. to Op. 4.1.05.01.0.

Take clutch dowm from the flywheel, after having marked mutual position.

- Remove worn flywheel ring gear, by cutting it by means of an abrasive elastic blade; the last 2-3 mm will give up if the made cut is forced by means of a chisel.
- Press the ring gear, heated previously up to 180°C, on a hydraulic press, paying attention to keep ring gear paralell to flywheel fruction surface.
- Refit all conponents on engine block, performing operations in reverse order and tightening bolts with the torques indicated in the Table XVI.

OP. 3.1.05.04.2 CHECKING CLEARANCE OF MAIN JOURNAL HALF-BEARINGS

- Take engine down from vehicle (Op. 2.1.10.01.0).
- Take gearbox & transfer box assy down from engine (Op. 2.1.10.01.1.)
- Take cylinder head down from engine block (Op. 3.1.10.04.0).
- Remove pistons from engine block (Op. 4.1.04.02.1).
- Take crankshaft down from engine, acc. to Op. 4.1.05.01.0.
- For checking clearance of main journal half-bearing, mount previously half-bearing and bearing caps and tighten bolts with a torque of 15.4 - - 16.8 m.daN (115 - 122 ft.lbs.). Then measure each bearing bore by means of a inner dial gauge set to a ring gauge.
- Determine also the ovality and taper of bearing bores.which should not exceed the prescribed limits.
- Now measure crankshaft journals, using a micrometer caliper. The measured dimension figures should also be within prescribed limits, as well as conicity & ovality of journals.
- If there will be found deviations on journals and bearings, perform bearing replacing and journal trueing up, rectifying them up to the undersize which will provide necessary clearances with new replaced bearings.

OP. CHECKING CLEARANCE BETWEEN BIG-END BEARINGS AND CRANK PINS

- Take engine down from vehicle (Op. 2.1.10.01.0).
- Take gearbox & transfer box assembly down from engine (Op. 2.1.10.01.1).
- Take cylinder head assy down from engine (Op. 3.1.10.04.0).
- Remove pistons from cylinder block (Op. 4.1.04.02.1).
- Take crankshaft from engine block, acc. to Op. 4.1.05.01.0.

  This operation is similar to Op. 3.1.05.04.1, with the only difference that the measured bores are these of big-end bearings, whose caps should be previously tightened with a torque of 6 - 7 m.daN (43.5 - 50.7 ft.lbs.).
  Operation can be performed also without taking crankshaft down, only on a single crank pin, suspected to have a too large clearance (which "knocks" during engine running), by dismantling only the crankdrive of respective piston.

OP. 4.1.02.03.0 TAKING CAMSHAFT ASSY FROM ENGINE

- Take engine down from vehicle (Op. 2.1.10.01, o).
- Remove cylinder head cover.
- Unscrew rocker arm adjusting screws, so as to neutralize pressure of valve springs.
- Remove push rods.
- Take down oil sump and its strainer.
- Remove timing gear cover, together with engine fore bracket and timing pointer.
- Rotate crankshaft one turn, in order to push outwards all tappets.
  Continue rotating crankshaft until through the distribution gear openings get successively accessible the two bolts fastening camshaft retainer falnge to cylinder block.
- Unscrew and remove the two bolts.
- Draw camshaft out, paying much attention to not damage with cams the camshaft bushes.

- After dismantling and checking the camshaft, refit it, performing operations in the following order:
- Fit spacer ring on camshaft, with large chamfer onwards.
- Press Woodruff key in keyway on camshaft.
- Fit retainer flange.
- Press distribution gear (with adjusting mark outwards) on camshaft until it abuts the spacer ring.
- Fit washer and lock washer, screw in fastening bolt and tighten it with a torque of 2 - 2.4 m.daN (14.5 - 17.5 ft.lbs.).

OP. 2.1.02.04.0. DISMANTLING & CHECKING CAMSHAFT

- After having taken camshaft down (see above Op.4.1.02.03.0), dismantle, if necessary, camshaft, as follows:
- Unscrew bolt fastening distribution gear on camshaft.
- Draw out distribution gear, by means of D 15 extractor.
- Remove Woodruff key, retainer flange and spacer ring.
- Wash camshaft in an adequate solvent, and wipe it dry.
- Inspect surface of cams for nicks, scratches, scorings or signs of excessive wear or traces of seizing. Generally speaking, cam wear is marked by nicks all over cam peak. If nicks are not severe, they do not prejudice operation of camshaft and the latter needs not to be replaced till lift of cam decreases by wear to the limit of max. allowed wear. i.e. 6.6 mm for inlet cams and 6.95 mm for exhaust cams.

  For checking lift of cam, measure with a micrometer caliper the diameter of can basic circle, comparing it with dimension measured over cam peak. The difference of both measurings indicates the cam lift.
- In case that the camshaft should be replaced, due to the faulty cams, the bushes should only be replaced if clearanse between bushes and journals of the new camshaft journals exceedes the prescribed limits of wear (0.150 mm).

ATTENTION: If the camshaft is to be replaced by a new one, due to faulty cams or other faults, the new camshaft should be "molycoted", i.e. the working surfaces of the cams, camshaft journals and ignition distributor drive gear should be smeared and frictioned a certain time with grease mixed with "molycote" (molybdenum disulphide), as was above indicated.

- Check distributor drive gear for wear and for broken or chipped teeth. Slight scorings, scratches, traces of seizing and nicks on camshaft on working surfaces can be removed by honing with a very fine-grit stone

CHECKING CAM LIFT WITHOUT TAKING IT DOWN FROM ENGINE

- Remove cylinder head cover, slacken rocker arm adjusting screws, till they get free from spring tension; shift rocker arms aside and lock them in this position.
- Check if the push rod rightly set in the tapper hollow. Set a dial gauge so that its feeler rests in tappet hollow - and in same direction as push rod.
- Turn crankshaft round slowly till tappet rests on basic circle of cam. The push rod will be in its lower position.
- Set the dial to zero and turn the crankshaftround again till push rod reaches its highest position.
- Note dial reading. Continue to turn crankshaft round till reading is zero and check precision of first reading. Proceed likewise with all cams.

OP. 3.1.02.02.0. CHECKING CLEARANCES BETWEEN CAMSHAFT JOURNAIS AND BUSH BORES

- Take engine down from vehicle, acc. to Op. 2.0.10.01.0.
- Take camshaft down from engine, acc.to Op. 4.1.02.03.0
- Check clearance between camshaft journals and bush bores, by measuring journals with a micrometer caliper and bush bores with a dial indicator, set to a ring gauge. If clearance resulted from difference between measures exceeds limit of wear of 0.150 mm, adjust journals, by rectifying up to undersize dimension and replace bushes by others with undersize

bore. The journals should also be adjusted to undersize dimension if their ovality exceeds the limit of wear (max. 0.015 mm).

OP. 4.1.02.05.0. TAKING DOWN & CHECKING THE TAPPETS

- Take engine down from vehicle (Op. 2.0.10.01.0).
- Take cylinder head down (Op. 4.1.10.04.0.).
- Take camshaft down, acc. to Op. 4.1.02.03.0).
- Remove from the block tappet cover, together with its gasket.
- Remove oil sump together wits its gasket.
- Remove also oil pump strainer.
- Remove tappets close to the crankshaft and inspect their wear condition. On their shoe surface should not be any nicks or traces of seizing or marked wear.
- Using a micrometer check rod diameter, in order to see if it is still within limits of wear.
- Check bores of tappet guides from cylinder block, near its upper surface, and find clearance between bores and tappet rods, which should be within indicated max. limits (limit of wear 0.150 mm).

  If clearances do not tally with above requirements, the tappets should be replaced by original new ones, together with the guide bushes. according to indications given in the chapter dealing with dismantling of cylinder block.
- Refitting should be performed in reverse order.

OP. 4.1.02.06.0. COMPLETE ENGINE DISMANTLING

- Take engine down from vehicle (Op. 2.0.10.01.0).
- Take gearbox & transfer box assy down from engine (Op. 2.1.10.01.1).
- Take cylinder head down from engine (Op. 3.1.10.04.0.).
- Remove pistons acc. to Op. 4.1.04.02.1.
- Take crankshaft down from engine (Op. 4.1.05.01.0).

- Take all external components from engine (Op. 3. 1. 10. 06. 0.).
- Take camshaft down from engine (Op. 4. 1. 02. 03. 0).
- Remove tappet cover, together with its gasket.
- Remove tappets from their guides in cylinder block.

IMPORTANT : On dismantling the engine take special care to avoid any oil penetrating upon the clutch disc.

During the engine dismantling inspect attentively any traces of wear on all components, as well as any deposits, in order to help the finding of any causes of wears.

- After having performed all measurings, necessary to establish the wear of cylinder liners, extract them from cylinder block.
- Unscrew bolts fastening the clutch housing and remove it.
- Unscrew plugs closing oil manifold of cylinder block.
- Unscrew lubricator fitting.
- Unscrew water drain cock.
- Press camshaft bushes out, by means of S 15 drift set., acc. to the Stage 4. 1. 02. 06. 3.

IMPORTANT REMARKK: The cluth housing will be taken down only in extreme cases, because the machining of the bore for centering gearbox is performed only when both components (clutch housing and cylinder block) are assembled, in order to privide coaxiality with the main bearing bores.

OP. 4. 1. 02. 06. 1. CHEKING & INSPECTING CYLINDER BLOCK

- Take engine down from vehicle (Op. 2. 0. 10. 01. 0.).
- Take gearbox down from engine (Op. 2. 1. 01. 01. 1).
- Take cylinder head down from engine (Op. 3. 1. 10. 04 . 0).
- Take external components and units from engine (Op. 3. 1. 10. 06. 0).
- Remove pistons from cylinder block (Op. 4. 1. 04. 02. 1).
- Take crankshaft down from cylinder block (Op. 4. 1. 05. 01. 0).
- Take camshaft down, acc. to Op. 4. 1. 02. 03. 0).
- Remove all other components left on cylinder block (Op. 4. 1. 02. 06. 0)

Now clean the processed mounting surfaces of remains of gaskets and then wash cylindor block with a suitable solvent.

- Clean out all oil ducts and blow them out with compressed air, in order to remove any traces of dirt.
- Check if all threaded bores for fastening cylinder head are clean. Correct threads by means of a screw-tap. Wash and blow out all threaded bores of cylinder block. Dirty threads may lead to jamming of bolts and consequently may give misleading values of torque used on tightening bolts.
- After cleaning and washing inspect the cylinder block minutely to disco - ver if any fissures exist, using the method described on cylinder block checking.
- Mounting surface for cylinder head and all other machined surfaces should be checked for burrs, scratches, corrosions, etc. Slight flaws may be removed by touching up with a very finegrained stone.
- The flatness of cylinder block mounting surfaces should be checked in the same manner as that of the cylinder head. If specified deviation is exceeded the respective mounting surface should be trued up. In no case the amount of stock removed should exceed 0.25 mm. Before trueing up surface, the cylinder liner should be pressed out.
- Inspect cylinder liner bores for scorings, scratches or ridges due to wear.
- Check ovality of liner bore by measuring with an inside comparator set to a ring gauge. The measurements should be carried out in three planes, perpendicularly to liner axis, at 7 and 75 mm from top of liner and again at 16 mm from bottom of liner.
- Check taper of liner in keeping with planes situated at 16 mm from bottom and 7 mm from top of liner. Maximal allowed ovality & taper of cylinder liners are givenin the Table IX, i.e. max. ovality is 0.0.13 mm, with the limit of wear of 0.125 mm and max. taper is 0.018 mm with limit of wear of 0.200 mm.
- Cylinder liners with bores exceeding limit of wear for ovality and/or taper should be reamed up to succeeding overzise. For this fasten the liner in D 17 device for grinding & honing cylinder liners.
- Cylinder liners having deep scratches or scorings should also be bored.

- If cylinder liners are within specified limits for ovality and taper, but have small superficial flaws, you can try to correct them by honing. In no circumstance, after honing, should the clearance between piston and cylinder liner exceed the specified limits (limit of wear is 0.230 mm at max. piston diameter). After honing replace piston rings.

  REMARK : Use for this honing only fine-grit stones.

- After touching up mounting surface (for cylinder head) or reconditioning cylinder liners you may press in cylinder liners. Fit every liner in its own place according to marks made prior to removal.
- Fit on two new bottom O-ring gaskets on each cylinder liner, leaving the middle groove free. Before fitting, check O-ring gaskets for uniform thickness all round and smooth surface without burrs or scores.
- Smear contact surface of cylinder block and O-ring gaskets with a soap solution. Introduce then liner in blook till it rests on first gasket and then press liner in by means of a pressing device.

St. 4.1.02.06.2 PROCESSING THE CYLINDER LINERS

Having cylinder block dismantled, as in the situation of On. 4.1.02.06.1, you can perform the trueing up of cylinder liners. Cylinder liners may be honed in case that on bore surface are only slight flaws as slight scratches, asperities, etc. The hones used should have the grain in keeping with bore surface quality. When it is necessary to remove more stock, use firstly hones with coarser grain.

- Perform then honing for finishing the bore up to correct clearance of piston, using a fine grained stones.
- If liner bores are gravely scratched or exceeding allowed limits of wear for ovality or taper, or for both, perform processing for each liner separately.
- To true up the cylinder liner, fasten it in D 17 device and perform trueing upon an internal grinding machine.

  The same D 17 device is used for fastening liner on honing.

- Process firstly the liners having the most important wear in order to establish necessary oversize dimensions. If last oversize is exceeded after honing, replace respective cylinder liner.

  IMPORTANT: All four liners should be processed up to the same oversize dimension.

- After grinding or honing, wash and wipe cylinder liners thoroughly so as to remove any trace of grit off working surface. For washing use an alkaline solution.
- After fitting liners in the engine block, smear them with graphiteor molycote oil.

St. 4.1.02.06.3. REPLACING CAMSHAFT BUSHES

When cylinder block is dismantled as indicated in Op. 4.1.02.06.1, you may replace the camshaft bushes. In case that camshaft bushes have an important wear, checked by means of an inside dial gauge, and do not ensure more the prescribed clearances, indicated in the paragraph 4.1.9.1.4., they should be replaced.

- To remove bushes firstly take down camshaft rear plug by pushing it with a rod introduced in camshaft spacing.
- Unscrew setscrew locking the middle bush.
- Press out successively bushes by means of S 15 drift set.
- New bushes should be pressed in with the same S 15 drift set.
- On pressing on new bushes take care that the oil holes in the bushes tally with the orifice in the cylinder block. Special attention should be payed to the middle bush as it is through this bush namely that the rocker arms are lubricated. After being pressed in, this bush should be secured against rotation by means of the set screw.
- Before mounting the camshaft rear plug (closing the bearing line), wipe bore clean, smear plug with an oil-proof nitrocellosic paint, or other leak-proof solution (as LOCKTITE, OMNIFIT, etc.), and press plug in using the S 15 drift.

OP. 4.1.10.02.0 REMEDYING TIGHTNESS OF CYLINDER LINERS FITTED IN ENGINE BLOCK

- Take engine down from vehicle (Op. 2.0.10.01.0).
- Take cylinder head down from engine (Op.3.1.10.04.6).
- Take oil sump down from engine.
- Remove pistions from cylinder block (Op.4.1.04.02.1).
- Draw out cylinder liners by means of D 303 extractor.
- Replace faulty O-ring gaskets on liners. The new O-ring gaskets should have no scores, burrs or fissures. Their thickness should be uniform
- Check edges of cylinder block bores, into which are pressed the cylinder liners with new O-ring gaskets: they should have no nicks or burrs. Small fawls should be removed carfully, using a fine-grit hone.

ATTENTION: Before remedying these fawls by honing, introduce under work area a collecting cloth, letting no lints; after finishing honning, remove carefully the cloth, in order to avoid any abrasive grits dropping upon around existing components.

- Now, fit new O-ring gaskets on cylinder liners; the middle groove should remain free.
- Smear area of two O-ring gaskets with a solution of 20% soap in water and then, using a hydraulic press, press liner in in the block.
- Refitting should be performed in reverse order.

OP.4.1.10.03.0. REMEDYING OIL LEAKAGES AT REAR MAIN BEARING

Operation can be performed in optimal conditions only after taking engine down from vehicle and after removing crankshaft. Namely:

- Take engine down from vehicle (Op.2.0.10.01.0).
- Take gearbox & transfer box assy down from engine (Op.2.1.10.01.1)
- Remove oil sump and oil strainer.
- Remove piston rod bearing caps, successively, by rotating crankshaft.

IMPORTANT: Perform this operation with much attention, in order to not damage crankshaft main journals and cylinder liner surface, when rotating crankshaft having bearing caps removed.

- Set engine in overturned position, having oil sump mounting surface upwards.
- Remove clutch housing, after having removed clutch control.
- Unscrew starting ratchet and draw out crankshaft pulley, using D 13 and D 14 devices.
- Take down timing gear cover, together with its gasket
- Remove oil slinger and pulley key from crankshaft.
- Remove rear bearing sealing cover, by unscrewing bolts fastening it (see Op. 4.1.05.01.0).
- Remove main bearing caps, together with half-bearings, after having marked mutual position of the components.
- Remove crankshaft, lifting it be means of a textile strap, passed under crank pin No.IV.
- Remove from cylinder bloc and from rear bearing sealing cover the graphite asbestos sealing cord.

Replacing sealing cord should be performed acc. to Stage 4.1.02.06.4.

On refitting the operations will be performed in reverse order and all bolts tightened with torques indicated in the Table XVI.

St. 4.1.02.06.4. REPLACING SEALING ASBESTOS CORD OF REAR BEARING

This stage should be performed as part of Op. 4.1.10.03.0 or then when the engine is completely dismantled and should be refitted.

- Introduce in the sealing seating of the engine block, where crankshaft gets out, a strip of "clingerite" (sealing plate of asbestos mixed with a binder), of 1 mm thickness, which should fit on the groove bottom.
- Introduce over it a half-ring of graphite asbestor cord, so that the packing cord arrow should be faced against crankshaft sense of rotation.
- Press the packing using a special pressing S 16 drift.

- The ends of packing cord, left over the block surface, should be cut using a very well sharped knife, as in the Fig. 4.66.

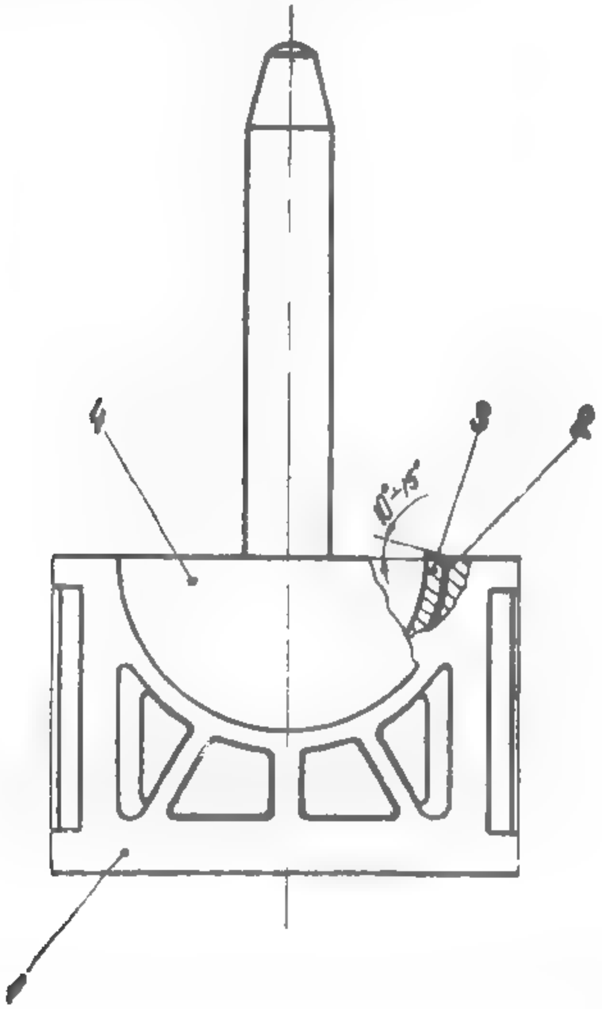


Fig. 4.66. INSERTING PACKING HALF-RINGS, BY MEANS OF S-16 DRIFT, IN THE REAR BEARING COVER.

- Perform the same operations on the bearing cover, and, after fitting crankshaft on the block and fastening it with the middle bearing cap, fit also the sealing rear bearing cover, tightening bolts with a torque of 6 - 7 m.daN (43.5 - 5.1 ft.lbs.)
- Further, perform respective operations.

OP. 4.0.10.07.0. TAKING DOWN THE CLUTCH CONTROL

- Remove the retracting spring between clutch release fork and clutch slave cylinder.
- Unscrew bolts fastening the assembled slave cylinder to the clutch housing.
- Remove the assembled clutch release fork by means of S 2 lever.
- After taking down, clean the assembled slave cylinder and test it for tightness. For this, introduce in it brake fluid, under a pressure of 90 daN/cm^2 (1280 lb/in^2). In a 3 minutes interval no leakage should appear and the pressure should not diminish by more than 1.5 daN/cm^2 (21.4 lb/in^2).

  If the result of the test is negative, the cause should be established and, either the piston cup, piston or cylinder should be replaced, according to circumstances.

  The clearance between piston and slave cylinder should be 0.025 - 0.077 mm.

4.1.9.4. REFITTING THE ENGINE

OP.4.1.10.08.0. SETTING ENGINE ON SPECIAL D 5 DEVICE

Here is indicated the performing of the engine refitting operations.

- After having washed cylinder block with an alkaline solution and after blasting it with compressed air, set it on special D 5 device.

a) REFITTING THE TAPPETS

- Wipe thoroughly tappet guide bushes, pressed in cylinder block.
- Smear each tappet shaft with graphite oil (10% colloidal graphite) or better with a mixture of oil and molybdenum disulfide ("Molycote"). Specially new tappets should be coated with molycote, prior to mounting.
- Introduce each tappet in its bush by slight rotation.

  Clearance between and guide bush should be 0.035 - 0.052 mm, so that tappet will glide down under its own weight.

b) FITTING THE CRANKSHAFT ASSY AND CLUTCH

REMARK: Before fitting up the crankshaft the oil ducts must be thoroughly cleaned (see Op. 2.1.05.02.0).

- Introduce into clutch housing rounded nut of clutch release fork and secure it with spring washer.
- Insert in rear stuffing box of cylinder block a strip of sealing material (Klingerite) and packing half-ring (graphite asbesto cord), by means of S 16 pressing drift (see Fig. 4.66).
- Trim ends of packing half-ring at $10^\circ - 15^\circ$, as shown in Fig. 4.66.
  The arrow on the plaited packing half-ring should point contrariwise to the running direction of crankshaft.
- Remove bearing caps.
- Smear journal half-bearings on cylinder block with graphite oil.
- Wipe journals and crank pins perfectly clean. Set crankshaft with great care on journal half-bearings, paying special attention to not damage the middle bearing flanges.
- Turn crankshaft over on journal half-bearings in order to lubricate hjournals.
- Fit upper thrust washers in middle bearing.
- Mount middle bearing cap together with lower thrust washers.
- By means of a lever, push crankshaft towards front of engine, so that crankshaft props against front face of upper thrust washer.
  Maintaining crankshaft in this position, push middle bearing cap towards back of engine, till the lower thrust washer props against crankshaft web. In this manner both halves of thrust washer are brought in the same plane.
- Tighten bolts of bearing cap with a torque of 15.4 - 16.8 m.daN (112 - 122 ft.lbs).
- Mount remaining half-bearing and bearing caps according to marks.
- Tighten bolts with the same torque as above. Tightening order of bearing caps: 3 - 4 - 2 - 1 - 5.
- Check if crankshaft turns easily after tightening of bolts, by means of D 18 cranking device (see Fig. 4.61).

Check axial play of crankshaft as follows:

- Push crankshaft backwards till it stops against the middle bearing thrust washer.
- Set dial gauge feeler contacting crankshaft flange, in such a manner that feeler rod is parallel to crankshaft axis.
- Set dial indicator to zero. Push crankshaft towards front of engine, till it rests against the thrust washer. The axial play is given by new reading of dial indicator, and should by within the limits (0.075 - 0.185 mm), the limit of wear being 0.180 mm.

  If axial play exceeds limit of wear, remove middle bearing cap and replace thrust washers.

  If axial play is below indicated limit, remove thrust washers and check them for blows or burrs.

- Insert in rear bearing cover a strip of sealing material (Klingerite) and packing half-ring (graphite asbestos cord), using the S 16 pressing drift. (see Fig.4.66.. Trim ends of packing half- ring at 10^{0}-15^{0}. Smear mounting surfaces of rear bearing cover with a seal paste (for instance: OMNIFIT, LOCKTITE). Fit plane washers and tightem special head bolts.
- Press wooden wedge seals till they are flush with cylinder block. Prior to pressing in they should be dipped in oil. If they are longer than necessary cut them with a sharp knife.

  REMARK : The crankshaft will be refitted only after having completely cleaned oil ducts and the chambers of centrifugal filter.

c) REFITTING THE PISTON & PISTON ROD ASSY

- Set the cylinder block on its side with cylinder bores horizontal.
- Remove big-end bearing cap & bearing.
- Fit S 17 assembling sleeve on piston (see Fig.4.62).
- Introduce piston in cylinder with mark towards timing gear cover.
- Pour oil on piston rings which should be set with their gaps at 120^{0}. Push piston in cylinder by means of a mounting drift, till big-end contacts crank pin.

- Smear crank pin with graphite oil. Fit big-end bearing and bearing cap.
- Take care that serial number of the bearing cap is on the same side as that on piston rod.

  hten nuts with torque wrench with a torque of 6.2 - 7 m.daN. (45 - 50.7 ft.lbs.).
- Tighten self-locking nuts with a torque of 0.4 - 0.5 m.daN (2.9 - 3.6 ft.lbs).
- Check if crankshaft turns easily by means of D 18 cranking device.
- Refitt remaining three assemblies in the same manner.
- Check axial clearance of big-end bearings by means of a feeler gauge set. The limits of clearance are 0.125 - 0.300 mm with limit of wear of 0.375 mm.

d) REFITTING THE CAMSHAFT

- Set cylinder block in initial position (vertically).
- Screw in grease nipple (Fig.4.67 - pos.1) with outlet towards distribution gear (2).
- Introduce camshaft in its location taking care not to damage bushes.

  REMARK: On refitting a camshaft its journals should be smeared with graphite oil.

  On replacing camshaft with a new one it should be performed its journals "molycoting" i.e. they should be smeared and frictioned a certain time with molycote oil (molybdenum disulfide in oil solution) in order to let penetrate molycote particles in journal pores.
- Mesh distribution gears so that timing marks coincide.
- Screw and tighten the two bolts for securing the retainer flange (3) after having fitted on lock washers.

  Check akial play of camshaft as follows:
- Push camshaft towards rear of engine. Set dial gauge with its feeler cantacting camshaft bolt. (whicle secures timing gear (2)
- Set dial indicator to zero.

ull camshaft forwards and let it go. The dial reading gives axial play which should be within prescribed limits, i.e. 0.111 - 0.174 mm, with limit of wear of 0.300 mm. If play is below or above specified limits either replace the spacer ring or the retainer flange, according to needs.

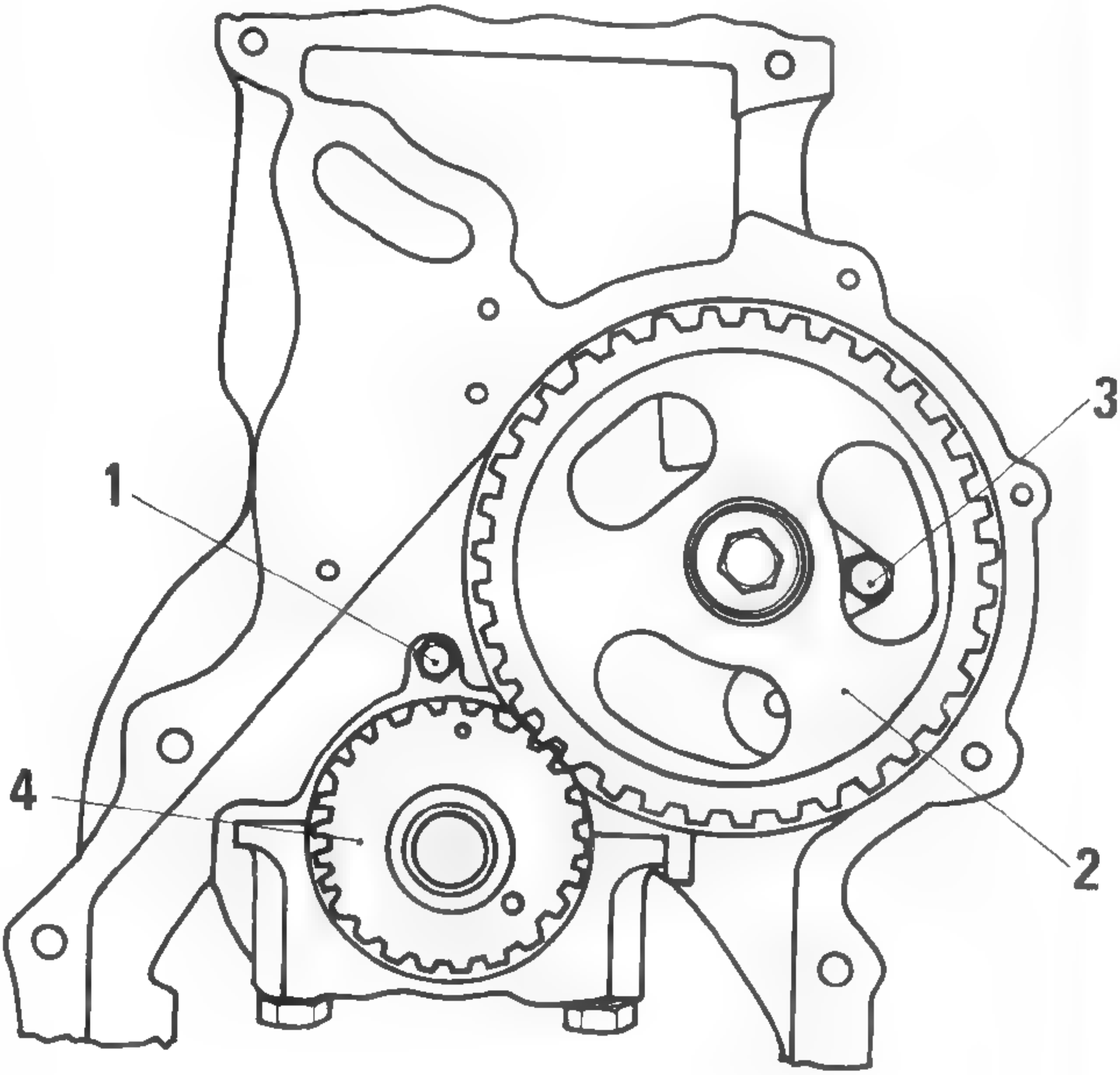


Fig. 4.67. REFITTING THE CAMSHAFT DRIVE GEAR
1- Grease nipple; 2- Camshaft assy; 3- Camshaft flange securing screw; 4- Distribution drive gear.

- Check backlash between teeth of distribution drive - and driven gear by setting dial gauge with its feeler contacting tooth profile (flank).

  rn distribution gear in both directions. The dial readings should be within limits of 0.049 - 0.149 mm.
- Fit gasket of timing gear cover over stud bolts.
- Press woodruff key in keyway on crankshaft.
- Press oil seal in location in timing gear cover.
- Set radial lip oil seal in camshaft gear cover (in case it was replaced).
- Fit camshaft gear cover on stud bolts.
- Mount timing pointer.
- Mount alternator adjusting link.
- Screw rest of bolts and nuts securing camshaft gear cover.

e) FITTING CRANKSHAFT PULLEY ON

- Oil the pulley locating surface with graphite oil and fi Woodruff key on pulley keyway. Then press pulley home up to refuse.
- Fit on lock washer and screw starting ratchet in, by means of D 13 device.
- Lock starting ratchet by bending washer.

f) REFITTING THE OIL SUMP & CLUTCH HOUSING COVER

- Fit oil strainer connecting pipe with gaskets on cylinder block.
- Set two gaskets on the bolts for fastening rear bearing cover, by using a sealing solution. (see Fig.4.1 - view from Z).
- Fit the oil sump gasket on cylinder block and over it the oil sump.
- Screw in bolts securing oil sump and tighten them with a torque of 1.7 - - 2.0 m.daN (13 - 14.5 ft.lbs.).

  ATTENTION : In the oil pump area fit the three special bolts (having higher head).

- Fit on clutch housing cover.

g) REFITTING THE CYLINDER HEAD

- Turn the engine with cylinder head mounting surface upwards and place it on special assembly stand.
- Clean mounting surfaces of cylinder block and cylinder head.
- Press in pilot sleeves if they happen to have been removed.
- Smear cylinder head gasket with a thin layer of colloidal graphite. Lay gasket on cylinder block with metal stiffener downwards (large water holes in gasket towards front of engine).
- Set cylinder head over gasket, with care. See that pilot sleeves fit in correctly.
- Oil and screw in by hand bolts securing cylinder head.
- Tighten bolts in the order specified in Fig. 2.2.4 with a torque of 7 - 8 m.daN (50.7 - 58 ft.lbs.).
- Tighten bolts anew, in the same order, with a torque of 12 - 13 m.daN (87 - 94 ft.lbs.).

REMARK: The cylinder head bolts should be retightened with engine warm (85°C, i.e. 185° F) and again when engine cools down, with the same maximal torque of 13 m.daN (94 ft.lbs.)

h) REFFITING THE ROCKER RAM SHAFT & PUSH RODS

- Dip end of push rods (1) - see Fig. 4.68 - in oil and fit them in marked order on each respective tappet.
- Fit discs on ends of exhaust valve stems.

REMARK: Before fitting on discs, check clearance allowing free rotation of valves.

- Set oil scoop (2) with oil drainage holes towards valves springs.
- Set rocker arm shaft assy (3) by fitting its supports (6) on stud bolts (9).
- Fit push rod ends to adjusting screws.
- Connect oil pipe (5) and pipe clamping plate to first rocker arm shaft support. The other end of oil pipe should be set in orifice of cylinder head, next to No. 1 exhaust valve stem.

- Screw in nuts and bolts, securing rocker arm shaft, and tighten them with a torque of 1.7 - 2.0 m.daN (12.3 - 14.5 ft.lbs.).

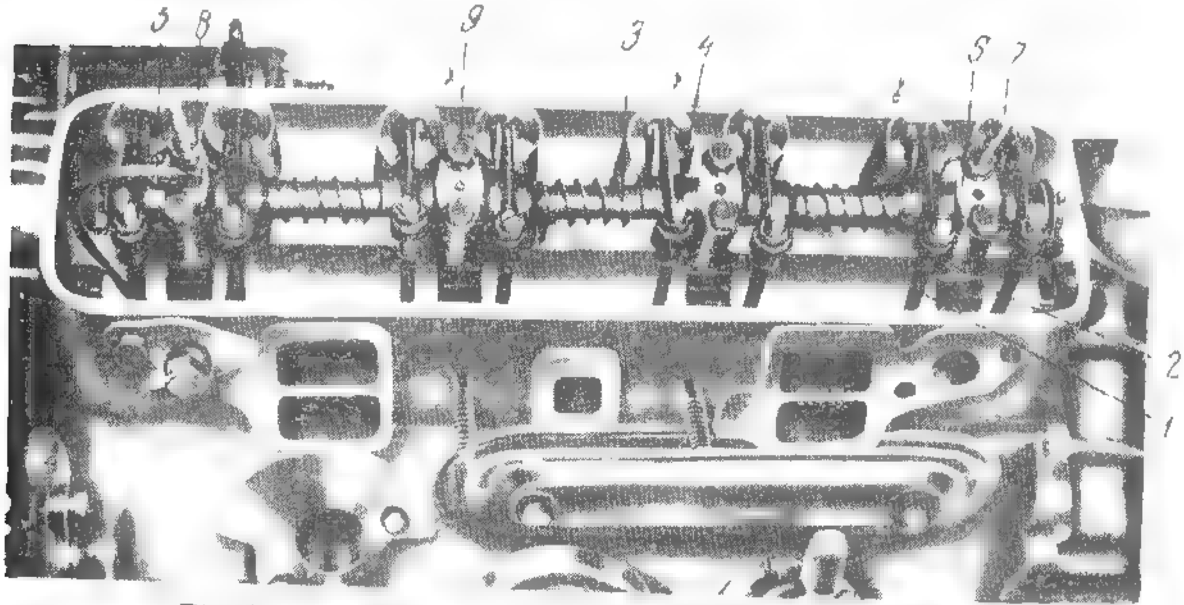


Fig. 4.68. ROCKER ARM FITTED ON CYLINDER HEAD.
1- Push rod; 2- Oil scoop; 3- Rocker arm shaft (mounted); 4- Adjusting screw; 5- Oil pipe; 6 - Rocker arm shaft support; 7- Stud bolt ; 8- Nut; 9- Bolt securing rocker arm shaft support.

h) ADJUSTING THE VALVE CLEARANCE

- The correct adjustment between rocker arm and valve is of the utmost importance to the good running order of the engine.
- Give the crankshaft 2 or 3 turns, to rid the tappets, push rods and adjusting screws of superfluous oil.
- Turn the crankshaft till mark "O" on damper of crankshaft pulley falls in line with timing pointer, No. 1 piston nears end of compression stroke (piston at its inner dead centre) and both valves are closed. In this position adjust 0.45 mm clearance of valves No. 1, 2, 4 and 6, i.e.:
  - exhaust & inlet valves of cylinder No. 1;
  - exhaust valve of cylinder No. 2;
  - inlet valve of cylinder No. 3.
  - To adjust clearance, proceed as follows:
  - Slacken special nut and turn adjusting screw till required 0.45 mm clearance is obtained. The clearance should be measured with a blade of 0.45 mm of a feeler gauge set. Now, retaining the adjusting screw, lock it by tightening special nut.

After locking adjusting screw, check clearance anew.

- Give crankshaft a complete turn (360°) till mark "O" on damper again falls in line with timing pointer and No. 4 piston nears end of compression stroke. In this position adjust clearance of valves No. 3, 5, 7 and 8, i.e. :
  - inlet valve of cylinder No. 2
  - exhaust valve of cylinder No. 3
  - inlet & exhaust valve of cylinder nNo. 4.

REMARK: The final adjustment of valve clearance should be carried out with a warm engine, i.e. after having run at least 30 minutes at a speed of about 1200 r.p.m. The clearance should also be checked after final tightening of bolts securing cylinder head (engine cold).

i) FITTING SPARK PLUGS & CYLINDER HEAD COVER

Screw spark plugs in their locations by means of a special S 18 box wrench.

- Smear gasket locating surface of cylinder head cover gasket with a sealing solution. Fit gasket in location on cover.
- Fit cylinder head cover over stud bolts.
- Fit the two rubber gaskets and washers, and screw on the rounded hex. nuts, tightening them with a torque of 2.8 - 3.5 m.daN (20 - 25 ft.lbs.).

j) REFITTING INLET MANIFOLD

- Fit stud bolts on cylinder head, in case they have been removed.
- Set inlet manifold gasket, fitting it over stud bolts.
- Fit bail clamps on stud bolts.
- Fit inlet manifold over gasket,, introduce washers and secure manifold with bolts.
- Fit on cover plate and fasten it by means oil bail clamps. Tighten bolts and nuts with a torque of (5.5 - 6.0 m,daN (40 - 43.5 ft.lbs.)

  The tightening should be performed in turn, from middle outwards.

k) MOUNTING THE IGNITION DISTRIBUTOR AND H.T. WIRE SET

- Fit distributor O-ring seal on ignition distributor.
- Remove distributor cap.

- Fit distributor gear assembly and oil pump drive shaft to distributor.

  REMARK: The distributor gear must be mounted together with the thrust washer and the lock washer.

- ...heck if the timing pointer is in line with graduation "A" on the crankshaft pulley damper, and piston No. 1 nears end of compression stroke.
- Set the distributor rotor in line with condenser terminal "X" (about 45° before the opening of the points contact corresponding to No. 1 cylinder). After that, introduce the distributor in its location, meshing it with the camshaft gear. The pinion meshing with the camshaft gear will rotate distributor, which will roughly reach opening position of contact for No. 1 cylinder.
- Screw in and tighten bolts securing the distributor to engine block.
- Slacken screw fastening distributor timing clamp. Lacking a test lamp, insert a cigarette paper between breaker points. Close points by rotating the distributor conter clockwise.
- Now, rotate distributor slowly in clockwise direction till the cigarette paper slips of from between contacts.
- Retighten screw of timing clamp, fixing thus the distributor in a position corresponding to a static advance of 4°. It corresponds to an ignition advance of 16° - 18°, , with the engine running at 1600 r.p.m. and with the vacuumm timing control suspended.

  REMARK: The correct 16 - 18° advance angle has to be adjusted, with running engine, by means of a stroboscope, using the timing marks on the crankshaft pulley damper.

- Fit again distributor cap on.
- Connect the four H.T. ignition wires to distributor cap terminals, as follows:
  - Terminal on cap marked 1 to No. 1 cylinder; remaining wires, conter lockwise around cap and in firing siquence 1-2-4-3.

  REMARK: On distributor cap, terminal No. 1 and sense of rotation are marked.

To adjust the distributor one generally use a tes lamp, serially connected to breaker. The lighting and extinction of the lamp indicate the make and break of contact.

l) REFITTING THE OIL FILTER

- Set filter seat (with its rubber gasket) on cylinder block, with the two holes upwards.
- Over the filter seat screw in assembling nut.
- Fit second gasket and oil filter, screw in filter centre shaft and tighten it with a torque of 2.5 - 3.5 m.daN (18 - 25 ft.lbs).

Pay attention to correct position gaskets while mounting.

m) REFITTING THE CARBURETTOR

- Fit on the inlet manifold flange, over the stud bolts, the following parts:
- First gasket, insulating gasket, second gasket, carburettor and lock washers.
- Screw in nuts securing carburettor.
- Set carburettor gasket and adapter on carburettor cover (upper body).
- Screw nuts securing adapter.
- Connect fuel feed tubing to carburettor and fuel pump. Fasten tubing with clamps.
- Connect vacuum connecting tube between carburettor and ignition distributor.

n) REFITTING THE WATER PUMP & COOLING FAN

- Position pump gasket and water pump on engine block, fitting hole on hole and fasten them with respective bolts.
- Fit connecting hose to thermostat elbow.
- Introduce on pump shaft, fitting hole on hole, the shim, fan pulley and fan assembly. Screw in and tighten the 4 bolts M 8.

Using the V 1 checker, check whether fan pulley and crankshaft pulley are coplanar. If not, change the shim.

o) REFITTING THE GEARBOX & TRANSFER BOX ASSEMBLY

- Check correct position of the clutch disc, in keeping with the crankshaft, using the D 4 splined centering drift.
- Fit throwout sleeve and coil spring on gear box.
- Hitch the gear box up and lift it to engine height, by means of a strip (which will allow a slight balance of the gearbox, so as t facilitate the fitting with engine) and a hoist.

- Engage any one of gears to couple main drive shaft.
- Set gearbox over stud bolts. To mate splines on main drive shaft with grooves in clutch hub, turn slowly the propeller shaft flange on transfer bo..
- Push gearbox up to refuse, over the stud bolts of the clutch housing.
- Introduce over the stud bolts lock washers and nuts and tighten nuts with a torque of 3 - 4 m.daN (22 - 29 ft.lbs.).

p) REFITTING THE HYDRAULIC CLUTCH CONTROL

- Fit clutch release fork on thrust ball stud of clutch housing, by means of S 2 mounting lever, passing fork under throwout sleeve clamps.

Fit slave cylinder assembly on clutch housing.

- Screw in rounded hex. nut on the slave piston rod, contacting clutch release fork, untill the thouwout sleeve bearing contacts the three adjusting screws on clutch on clutch release levers.
- Unscrew rounded hex. nut one whole turn, to ensure the necessary clearance of 0.5, between throwout bearing and tips of adjusting screws.
- Lock rounded nut, by tightening back nut.
- Mount retracting spring between slave cylinder and clutch release fork.

r) FITTING UP THE FUEL PUMP

- Fit bolts through the pump flange, introduce sealing and insulating gasket over the bolts and fit pump on cylinder block.
  - Tighten the bolts fastening the fuel pump.
- Connect fuel pump to carburettor.

s) INSTALLING THE ALTERNATOR

- Fit on the engine block the alternator support, tightening the two bolts with a torque of 3.7 - 4.1 m.daN (27 - 30 ft.lbs.).
- Pass alternator lug through support eye end intruduce through both of them titting bolt. Tighten nut of tilting bolt with a torque of 2 - 2,4 m.daN (14.5 - 17.5 ft.lbs.), and secure it.

Check coplanarity of the pulleys, by means of V 1 check r. If necessary, adjust complanarity, by shifting alternator support, whose bolts holes are oval.

- Fit V-belt on the three pulleys.
- Tilt alternator and fasten it to V-belt tensioner. Strech V-belt by deplac-

ing alternator with a lever and tightening alternator fastening bolt, with a torque of 2.2 - 2.5 m.daN (16 - 18 ft.lbs). V-belt stretching may be considered correct if on being depressed between alternator and water pump pulley, its dip is ou about 15 mm.

t) COMPLETING ENGINE REFITTING

- Go on with refitting the following components and units:
  - Thermostat elbow
  - Exhaust manifold
  - Oil pump (before refitting it should be fetched with oil)
  - Oil relief valve, if it has been removed.
  - Oil dip stick
  - Starting motor
  - Water hoses connecting water pump, thermostat elbow, cylinder head and inlet manifold.
  - Temperature and oil pressure transmitters.
  - Water draining cock.

Finaly top up engine and gearbox & transfer box assy with fresh adequate oil.

4.1.9.5. RUNNING IN THE ENGINE

OP. 4.1.10.09.0. RUNNING IN AFTER OVERHAULING

After having overhauled the engine it is necessary to run it in on a test bench.

So as to be able to trace any leakings it is absolutely necessary that engine outside should be wiped clean.

For cold running in use an electric motor to drive engine, while for warm running in, with load, a test bench with hydraulic brake is necessary. The running in rate is shown in the Table XVII:

TABLE XVII

THE ENGINE RUNNING IN RATE

Running in condition	Engine speed (r.p.m.)	Brake load m.daN	Running time (min)	Remarks
Cold running in:				
- Decompressed engine	500-700	-	10	Without spark plugs
- Compressed engine	500-700	-	20	With spark plugs
- Compressed engine	1000-1200		30	Ditto
Warm running in:	1200	0	15	
	800	0	5	
	1500	3	15	
	1900	6	20	
	2200	10	20	
	1700	8	55	
	1900	8	40	
	600	0	5	
	2200	10	40	

- After cold running in oil should be changed without any exception what soever.
- During running in, pay attention for following items:
- - If any local overheating occurs.
  - If chattering of ta ppets, piston pins, journals, etc. is heard.
  - If any oil or water leakages occur.
  - If oil pressure is at least 0.8 bars (11.4 lb/in^2).
  - If any of above troubles are noticed, interrupt running in operation and remedy respective trouble.
- During running in, the following temperatures should be maintained:
  - 70 - 85° C for water, i.e. 150° - 185° F
  - 75 - 95° C for oil i.e. 167° - 203° F

In order to check quality of engine averhauling, after having finished the running in, the following tests should be carried out:

1. Working order test. At a speed of 1800 - 1900 r.p.m. of crankshaft and a brake load of 8 m.daN (58 ft.lbs.) the fuel consumption should not exceed 235 ± 5 gr/H.P.h.

2. Steadiness test.

At 1900 r.p.m., with a brake load of 8 m.daN (58 ft.lbs), the speed, measured every 3 minutes, should not vary more than ± 50 r.p.m. in 9 minutes time.

3. Starting test

Try three times to start engine, which must start at least once.

The starting is considered as unsatisfactory if engine does not start in 5 seconds after switching starting motor.

REMARK. Crank engine with starter motor for no more than 15 seconds.

TABEL XVI

TABLE OF TIGHTENING TORQUES ON ARO L-25 ENGINE REPAIR

Ref. No.	ASSEMBLY OF UNIT TO BE FASTENED (bolts or nuts to be tightened)	Prescribed m.daN	torque ft.lbs
1	Piston rod self locking nuts	6.5 - 7.0	47 - 50.6
2	Big-end bearing cap back nuts	2.5 - 3.0	18 - 21,7
3	Bolts securing timing gear cover	1,4 - 1.6	10 - 11,5
4	Bolts securing oil sump on block	1.7 - 2.0	12 - 14.5
5	Bolts fastening oil sump on block	1.7 - 2.0	12 - 14.5
6	Bolts securing rocker arm shaft support	1.7 - 2.0	12 - 14.5
7	Bolt securing distribution gear on camshaft	2,0 - 2.4	14.5 - 17.3
8	Bolts fastening clutch to flywheel	2.5 - 3.6	18 - 26,0
9	Bolts fastening flywheel to crankshaft	5,0 - 5.7	36 - 41,2
10	Bolts fastening cylinder head - first tightening	7.0 - 8,0	50.6- 57.8
11	Ditto - second tightening (engine cold)	12,0 - 13.8	86.8- 94.0
12	Bolts securing main bearing caps	15.5 - 16.5	112.0-119.3
13	Bolts securing alternator pulley on its shaft	4.0 - 4.5	29.0- 32.5
14	Bolts securing alternator end shields	0.7 - 0.8	5.0- 5.8
15	Nut of alternator "B" terminal	0.4 - 0.5	2.9- 3.6
16	Nuts of alternator "D" terminal	0.25 - 0.3	2.8- 3.2

Ref. No.	ASSEMBLY OF UNIT TO BE FASTENED (bolts or nuts to be tightened)	Prescribed torque m.daN	fr. lbs
1	Bolts fastening alternator bracket on block	3.7 - 4.1	26.7 - 29.6
18	Bolt fastening alternator to its bracket	2.0 - 2.4	14.5 - 17.4
19	Bolt fastening alternator to belt tensioner	2.2 - 2.5	16.0 - 18.0
20	Bolts fastening inlet manifold on block	5.5 - 6.0	39.8 - 43.4
21	Bolts fastening exhaust manifold on block	7.0 - 7.5	50.6 - 54.2
22	Bolts fastening muffler fore pipe to cylinder head	3.0 - 4.0	21.7 - 29.0
23	Bolts fastening gearbox to clutch housing	3.0 - 4.0	21.7 - 29.0
24	Bolts fastening clutch housing to block	6.5 - 7.5	47.0 - 54.2
25	Bolts securiting water pump on block	3,5 - 4.5	25.3 - 32.6
26	Bolts securing camshaft retainer flange	2.0 - 2.4	14.5 - 17.4
27	Bolts fastening sealing cover on block	6.0 - 7.0	43.4 - 50.6
28	Bolts fastening cylinder head cover	2.8 - 3.5	20.3 - 26.0
29	Oil filter centre shaft	2.5 - 3.5	18.o - 25.3

4.2. ARO D 127 DIESEL ENGINE

4.2.1. PRESENTATION OF ENGINE

4.2.1.1. DESCRIPTION OF ENGINE

D 127 engine, which epuips ARO vechicles is a four stroke, high speed Diesel engine, with four cylinders. The iron cast cylinder block has four detachable wet liners, supported by upper block face.

The carnkshaft, made of special high-strength nodular cast iron, is supported on 5 main bearings, fitted with babbit half liners.

The pistons are aluminium alloy castings, fitted with floating piston pins. Each piston has two piston rings (the upper ring is chrome-plated) and an oil scraper ring with expansion ring.

On the piston top is a toroidal shape combustion chamber, corresponding to direct injection.

The steel forged piston pins provide through a hole piston pin and cylinder liner lubrication and through other one the cooling of piston.

The camshaft is located in cylinder block, being driven by crankshaft by the agency of a helicoidal gear.

The engine is fitted with two cylinder heads (each for two cylinder), bearing inlet-and exhaust valves.

The fuel pump provides fuel supply pressure, sufficient to overcome the hydraulic resitance of both fuel filters, connected in series.

The rotary fuel injection pump has a centrifugal, mechanical governor for all speeds and an automatical control device.

The fuel injectors are provided, each of them, with atomizer with four holes.

The engine is lubricated by oil pressure, provided by a gear pump, with an inbuilt pressure relief valve. The pump is driven by the camshaft.

The oil filter, connected in series, has a by-pass valve, which allows oil to pass directly, when filtering element gets clogged.

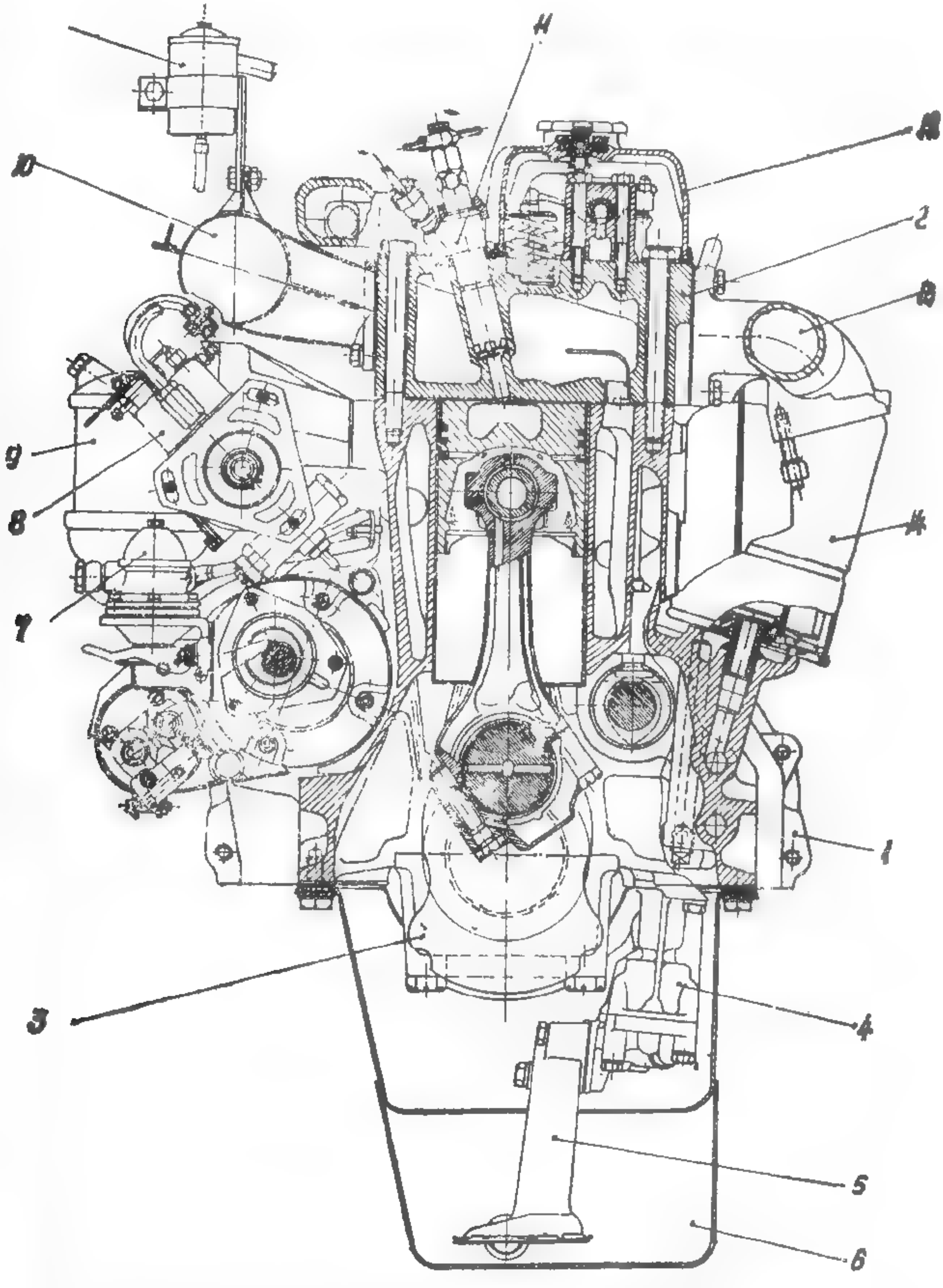


Fig. 4. 70. CROSS SECTION OF ARO D-127 DIESEL ENGINE
1. Cylinder block; 2- Cylinder head; 3-Crankshaft; 4- Oil pump; 5- Oil strainer; 6- Oil sump; 7- Fuel pump; 8- Injection pump; 9- First fuel filter; 10 - Inlet mainifold; 11- Injector; 12 Cylinder head cover; 13- Exhaust manifold; 14- Oil filter; 15- Second oil filter.

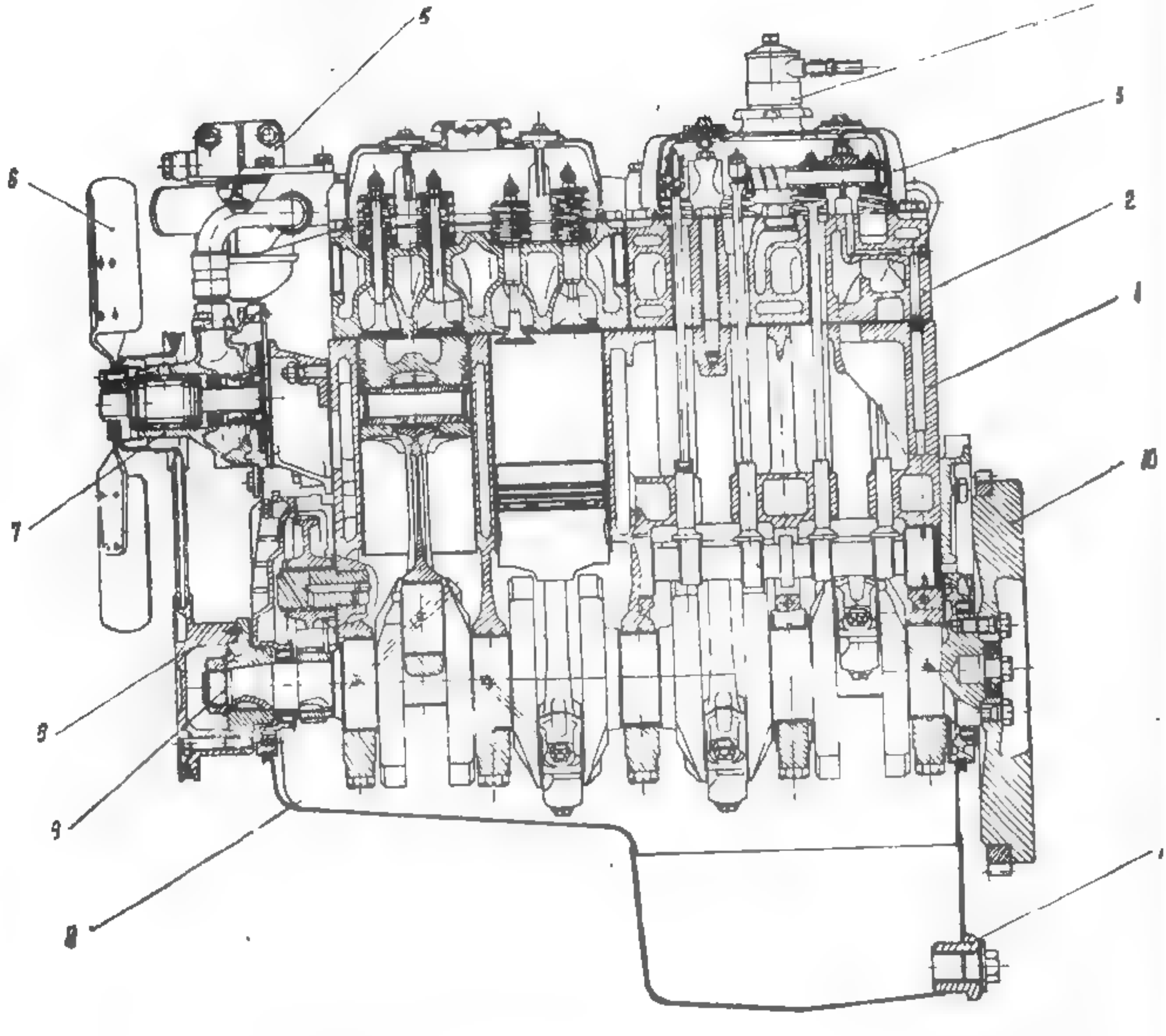


Fig.4. 69. LONGITUDINAL SECTION OF ARO D-127 DIESEL ENGINE

1- Cylinder block; 2- Cylinder head; 3- Cylinder head cover; 4- Fuel filter; 5- Fuel filter; 6- Cooling fan; 7- Water pump; 8- Crankshaft pulley; 9- Crankshaft; 10- Flywheel; 11- Oil sump; 12 - Draining plug.

The cooling system is provied with a thermostat, which shortens cooling radiator untill engine working temperature is reached.

The circulation of cooling fluid is provied by a centrifugal pump, mounted on engine block, and driven by the crankshaft pulley and a V- belt.

- The engine starting is provided by a 3 kW/12 V starter motor.

4.2.1.2. MAIN SPECIFICATIONS OF D 127 DIESEL ENGINE

- Make	I.M. MUSCEL Factory
- Model	D 127
- Type	Diesel engine, four stroke, direct fuel injection
- Nominal ootput (acc. to rumanian standard)	47.8 ± 5 % kW (65 H.P.)
- Nominal output speed	3,200 r.p.m.
- No load max. speed	3,380 - 3,400 r.p.m.
- Idling speed	700 - 800 r.p.m.
- Maximal torque (at 1600 r.p.m.)	18,1 ± 5 % m.daN (131 ft.lbs.)
- Nominal output troque	14.2 ± 5 % m.daN (103 ft.lbs.)
- Cylinder bore	95 mm
- Piston stroke	110 mm
- Cylinder capacity	3.119 cm^3 (190.334 cb.inch)
- Compression ratio	17 to 1
- Injection order	1-3-4-2
- Sens of rotation (regarding engine from the fan side)	clockwise
- Min. fuel consumtion	272 g/kWh (202 g/H.P.h)
- Valve position	in cylinder head
- Opening of inlet valve	3^o before I.D.C. (inner dead centre)
- Closing of inlet valve	43^o after O.D.C. (outer dead centre)
- Opening of exhaust valve	$48^o30'$ before O.D.C.
- Closing of exhaust valve	6^o after I.D.C.

Clearance of valve (with warm engine):	
- inlet valve	0. 25 mm
- exaust valve	0. 35 mm
- Rotary fuel pump	CAV type, with automatic DPAM-3842 FO1O advance governor
- Fuel injectors	KBL-70S1R type, with atomizer DLLA - 145 - S 448 type.
- Injection fuel pressure	226 $\pm$ 5 bars (3,214. 4 lb/sq. inch)
- Total injection advance	37^{0} (18^{0} fixed advance and 19^{0} automatical advance).
- Fuel filters	two filters, connected in serial, fitted with micronical paper elements)
- Air cleaner	minimal filtering rate 98. 5 %; prresure drop, at maximal speed: 350 mm water column.
- Oil pressure in lubricating system	3 - 4 bars (42. 7 - 56. 9 lb/sq. inch) at maximal speed, and 0. 5 bars (7. 1 lb/sq. inch) at idling speed.
- Oil pump capacity	25 ℓ/min.
- Engine lubricating system capacity	7. 5 litres
- Max. oil consumption, after 1,500 km operation	1 % of fuel consumation
- Max. oil temperature	110^{0}C (230^{0} F)
- Cooling water temperature, at nominal (rated) out put	75^{0} - 95^{0} (167 - 203^{0} F)
- Smoke figure at:	
- rated output	3,5 n. Bosch
- max. torque	4, 3 n. Bosch
- Alternator	1132 type - 12 V /36 A, with en closed rectifying system.

- Engine dry weight 360 kg (634 lbs.) (enclosed the clutch gearbox and transfer box assy).

4.2.2. TROUBLES & REMEDYINGS OF THE FUEL SUPPLY SYSTEM

4.2.2.1. DESCRIPTION OF FUEL SUPPLY SYSTEM

The fuel supply system, which allows direct fuel injection into combustion chamber of the piston top consists of the following components.

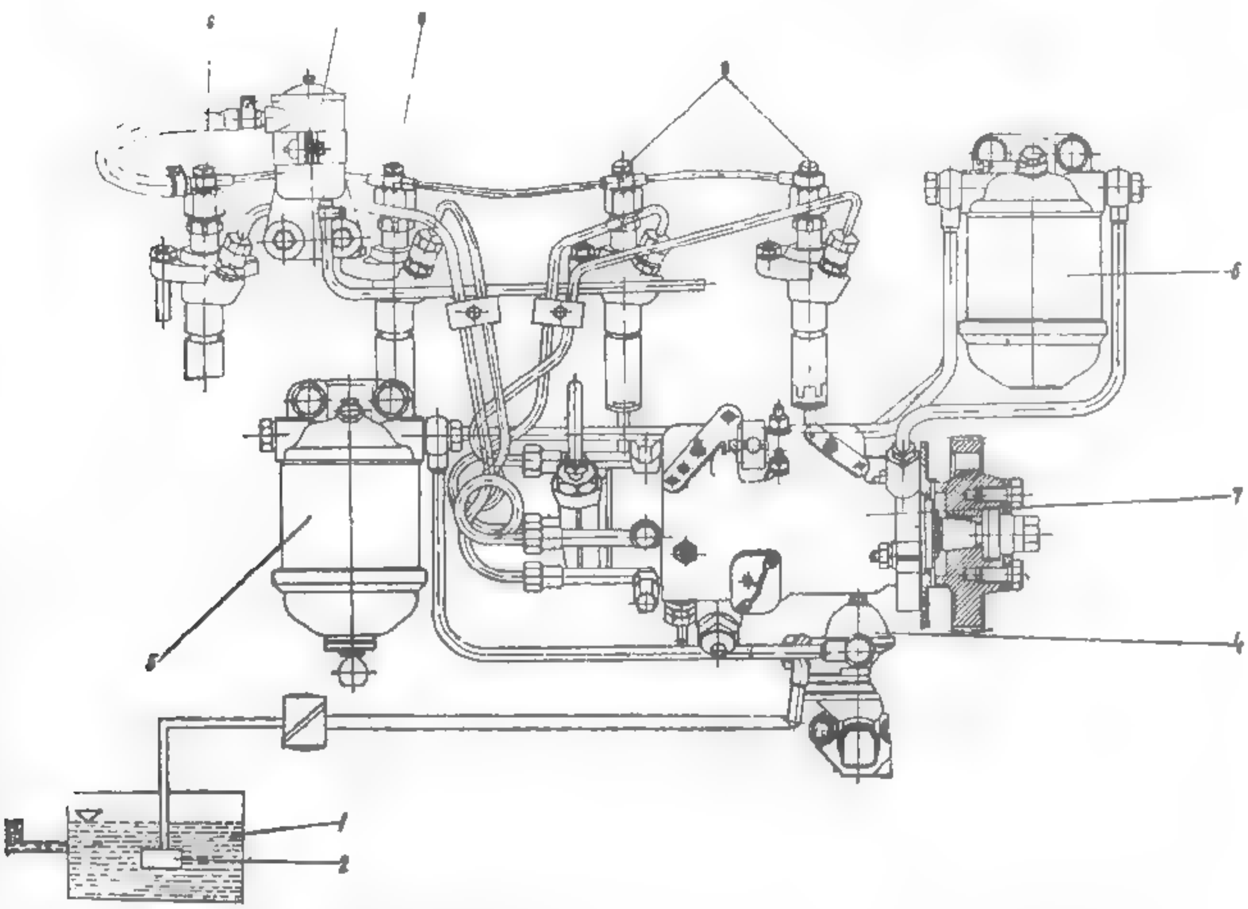


Fig. 4.71. FUEL SUPPLY SYSTEM
1. Fuel tank; 2- Fuel strainer; 3- Straight-way filter; 4- Fuel pump; 5-Aglommerarting filter; 6- Micronical filter; 7- Rotary injection pump; 8- Cylinder injectors.

Fuel supply pump, with double diaphragm and primer.

- Two fuel filters, connected in series, the first being provided with sediment bowl and a device for its periodical cleaning.
- Injection pump CAV, of rotary DPAM 3842 FOLO type, with mechanical all speed governor and device for automatic advance control.
- Four KBL 705 1 R type injectors with DLLA 145 S 448 type atomizers calibrated for a pressure of ± 5 bars (3214,4 lbs/sq. inch).
- Supplementary tank which collects fuel excess injectors and provides supply of thermoinjector. (see Fig. 4.71).

4.2.2.1.1. FUEL SUPPLY PUMP

The fuel supply pump, with two diaphragms, is actuated by an excentric, which moves the disphragms driving rod.

It has an inlet and an outlet valve. On checking the pump one should inspect the valves for clogging and diaphragm for break.

On dismantling the pump, rotate the double diaphragm a 1/4 of turn in order to make free the rod end from driving lever.

The minimal fuel pump delivery is 120 ℓ/h and the delivery pressure is of 0.5 bars (7.1 lbs/sq. inch).

4.2.2.1.2. FUEL FILTERS

Two fuel filters, connected in series, from which the first with sediment bowl, provides removal of impurities - water drops and solid impurities - and the second by micronic filtering.

REMARK: After replacing the filtering element the fuel supply system should be deaerated.

4.2.2.1.3. FUEL INJECTION PUMP

The fuel injection pump rotary DPA type, with mechanical governor, is a compact, self contained unit, for high speed multicylinder Diesel engines It is a relatively simple design, and incorporates no ball or roller bearings, gears or highly stressed springs, having thus a high endurance. The pump is flange mounted to the engine. It is oiltight and needs no lubricating system. During ist operation all parts are adequately lubricated by filtered fuel oil under pressures, which fills completely the whole pump. Pressure maintained within the pump housing prevents the formation of air locks and the ingress of dust, water and other foreign matter, which oculd damage the pump and trouble its good operation.

Injection pumping is effected by a single element having twin opposed plungers within a transverse bore in a central rotating member which acts as a distributor of the fuel to the four injectors and revolves in a stationary member known as the hydraulic head.

The central rotating member and the plungers, on the one hand, and the hydraulic head on the other hand, are assemblies matched in the manufacturing factory and in no case they should be disassebmled.

The pump plungers, during pump operation, are actuated by lobes on a stationary cam ring. Fuel is accurately metered to the pumping element, and the high pressure charges are distributed to the engine cylinders, at the required timing intervals, through ports in the rotor and the hydraulic head.

The integral governor, of mechanical simple design, gives accurate control of engine speed under all load conditions. The pump has also an automatic device which varies the point of commencement of injection, according to engine speed.

The single pumping element ensures uniform delivery of fuel to each engine cylinder, and obviates the need to balance the deliveries from each of the high pressure delivery pipes, necessary with all multi-element pumps. (see Fig. 72).

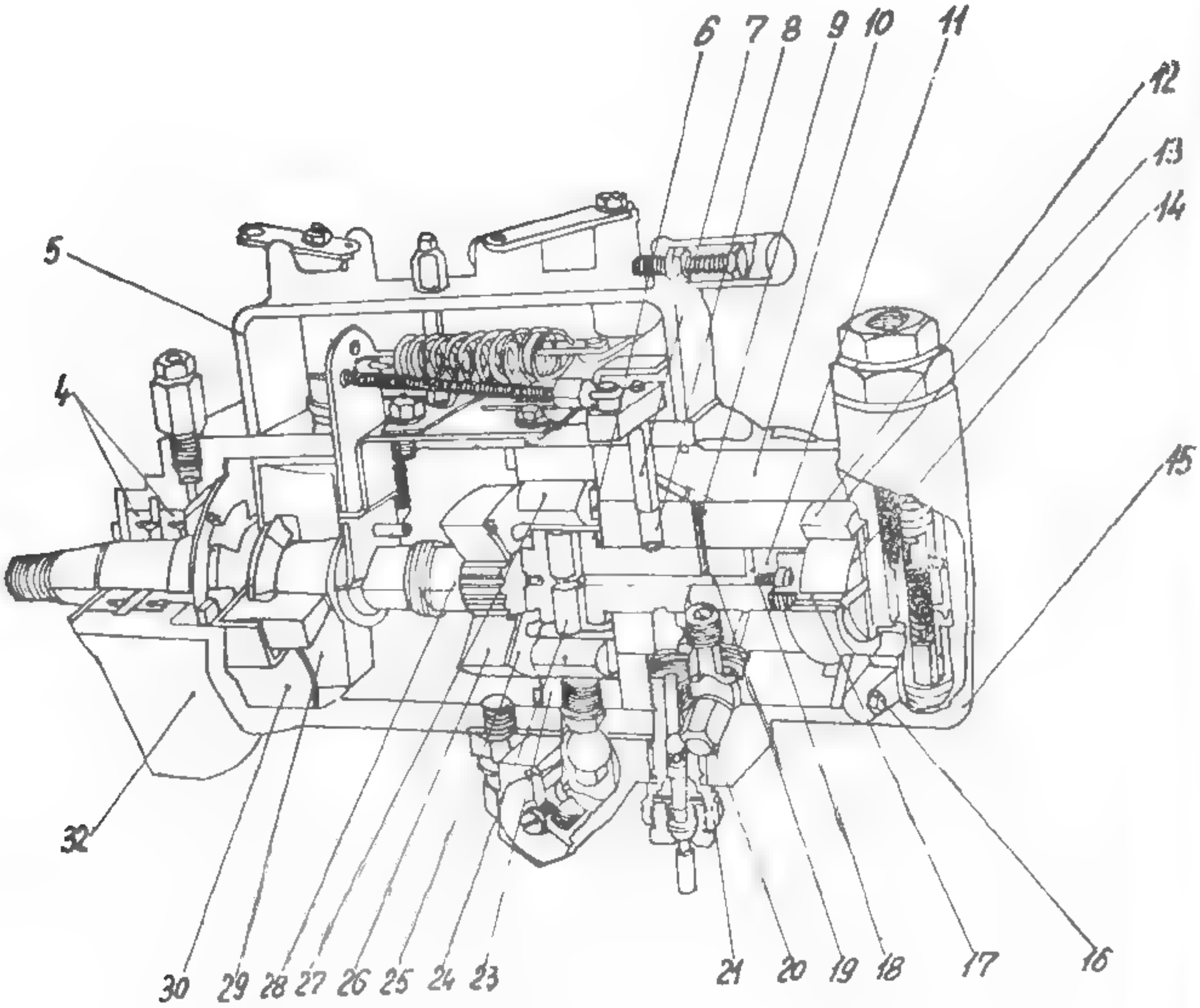


Fig. 4.72. DIESEL FUEL INJECTION PUMP

1- Fuel return line union; 2- Fuel inlet union; 3- Hydraulic head· 4- Pump shaft sealing rings; 5- Fuel pump cover; 6- Adjusting plate witn rear slits; 7- Metering valve; 8- Annular port; 9-Metering radial port; 10- Hydraulic head sleeve; 11- Pump rotor; 12- Pump stator; 13-Sealing gasket; 14- Transfer pump rotor; 15- Regulating valve housing; 16- Bolt fastening covering plate; 17- Transfer pump sliding blades; 18- Radial delivery ports; 19- Radial inelt port; 20-High pressure union; 21- Hydraulic head union; 22- Plunger shoe; 23- Cam ring; 24- Plungers; 25- Adjusting plate with front slits; 26- Rotor driving plate paired with shaft (28); 27- Plunger push rollers; 28- Pump drive shaft; 29- Governor weights; 30- Covernor weights housing; 31- Manual advance device; 32- Throttle link end.

THE WORKING PRINCIPLE

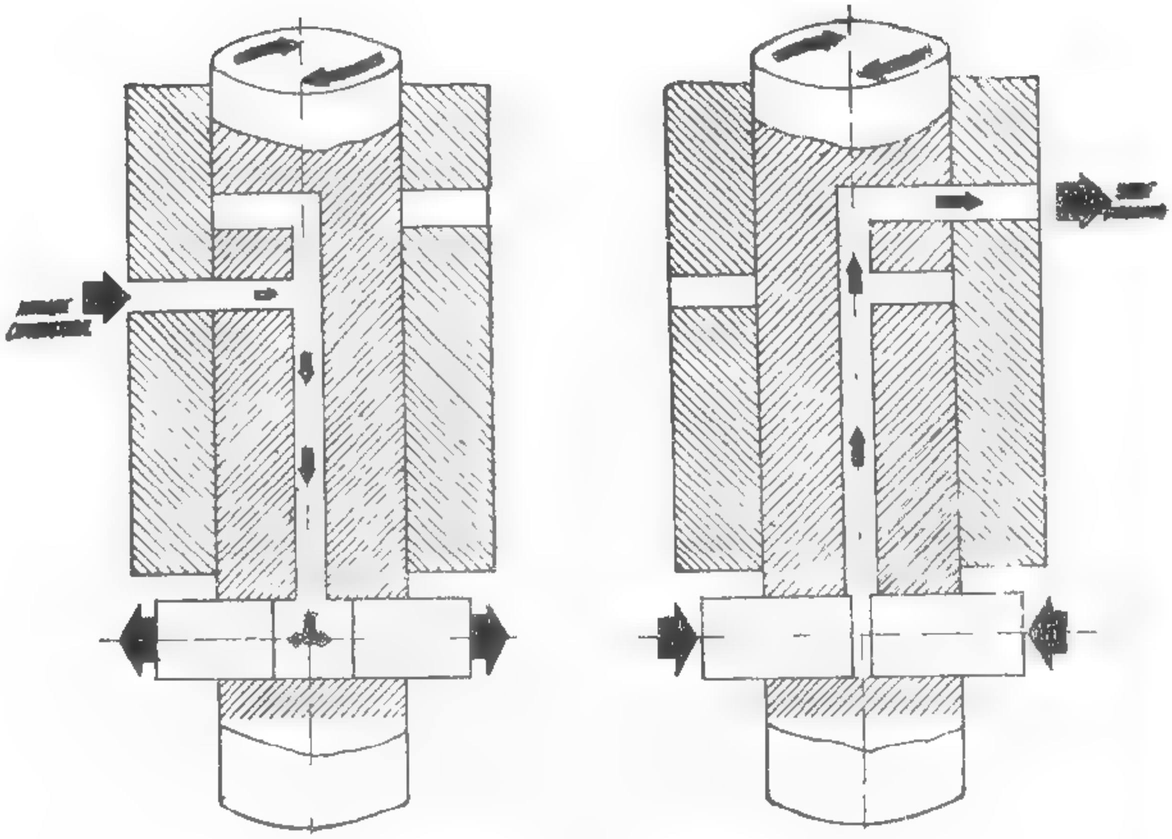
The stationary internal cam ring, mounted in the pump housing, normally has as many lobes as there are engine cylinders (in the present case, four) and operates the opposed pump plungers through cam rollers carried in shoes sliding in the rotor body. The plungers move inwards simultaneously as the rollers contact the diametrically opposed cam lobes and are returned by pressure of the inflowing fuel.

The working principle is shown in Fig. 4.73, where the pumping and distributing rotor is shown at the inlet position (on the left) and at the injection position (on the right). The pump plungers move outwards under pressure from fuel flowing in from the metering port and through an inlet port in the rotor to a central axial passage opening into the pumping chamber.

As the rotor turns (Fig. 4.73), the inlet port is cut off, and the single distributor port in the rotor registers with an outlet port in the hydraulic head. At the same time the plungers are forced inwards by the rollers contacting the cam lobes, and fuel under pressure passes up the central bore of the rotor through the aligned port to one of the injectors. The rotor has as many inlet ports as the engine has cylinders, and a similar number of outlet ports in the hydraulic head.

When fuel enters the main inlet connection it passes through a sliding vane transfer pump carried on the rotor inside the hydraulic head, through a matering valve and through passages to the pumping element. The transfer pump increases the fuel pressure and the metering valve, actuated by the engine control lever or by the governor, regulates the amount of fuel delivered to the pumping element.

The outward travel of the opposed pump plungers is determined by the quantity of fuel delivered, which varies in accordnce with the setting of the metering valve. In consequence, the rollers which operate the plungers do not follow the contour of the internal cam lobes at points which vary according to the degree of plunger displacement. The maximum omount of fuel delivered at one charge can thus be regulated by controling the outward travel of the plungers.



a b

Fig. 4.73. OPERATING OF ROTARY FUEL PUMP
- poz. a = inlet; poz. - b = delivery

The cam lobes are contoured to provide relief of pressure in the injector lines at the end of the injection cycle· this gives a sharp cut-off of fuel and prevents "dribble" at the nozzles.

The accurate spacing of cam lobes and delivery ports governs the timing interval between injections, and components which affect timing are designed with one assembly position only to ensure precision.

The pump rotor is driven by the engine through a splined shaft, keyed shaft or other drive to suit the engine manufacturer's requirements. In the case of D 127 Diesel engine, the pump is driven by the shaft taper end and Woodruff key.

This pump is governed mechanically and the governor flyweight assembly is mounted on the drive shaft and is contained entirely within the pump body Linkage transmits the movement of the governor flyweights to the control lever

on the metaring valve, the governor mechanism being enclosed in a housing mounted on the pump body.

On the pump side, opposite to the drive shaft, is fastened, on hydraulic head, the regulating valve whose role will be explained further.

a) FUEL METERING

Except very low losses, which occur during delivering, the totality of the pumped fuel reaches the injector. For this reason the injected fuel is metered, by varying the fuel volume at each charging stroke. The volume of the charge is governed by two principal factors: the fuel pressure in the metering port, and the time available for fuel to flow into the element while the inlet port in the rotor and the metering port in the hydraulic head are in register. It is by controlling the pressure in the metering port that accurate metering is achieved.

Fuel enters the pump inlet at feed pressure and passes to the transfer pump, which rises the feed pressure to an intermediate value, termed the t r a n s f e r pressure. As the transfer pump vanes are mounted on the rotor, transfer pressure rises when the engine speed is increased. A regulating valve maintains a predetermined relationship between transfer pressure and speed of rotation by returning part of the fuel to the pump inlet.

Fuel at transfer pressure passes to the metering valve which controls the quantity that flowes to the pumping element. The effective area of the metering port is controlled by movement of the metering valve, which is connected by control linkage to the accelerator pedal and governor. A pressure drop occurs as fuel passes through the metering orifice, reducing pressure to a level known as metering pressure. The smaller the metering port orifice, the greater will be the decrease in pressure and vice versa.

Fuel from the metering valve passes through an obliquely drilled passage in the hydraulic head to an inlet port and the pump. Fuel pressure in the rotor is alternately at high pressure on the injection stroke, and at metering pressure on the filling stroke.

A controlled hack leakage of fuel passes between rotor and hydraulic head, plungers and bore, etc. for lubricating purposes. This fuel fills the pump body and is returned to the filter.

At idling speed both transfer pressure metering pressure are at minimum value. Depressing the accelerator move the metering valve to a position where the effective area of the metering port is increased. This increases the metering pressure and consequently an increase in the quantity of fuel entering the injection pump for each charging stroke. The engine will then accelerate in response to increased fuelling until a speed corresponding to the position of the accelerator is attained. When the pedal is released, the effective area of the metering port is reduced and engine speed will fall because of reduced fuelling.

When the engine is running at a fixed speed setting, the governor controls the position of metering valve and maintains the selected speed within close limits by causing compensating changes of fuelling.

b) PUMPING AND DISTRIBUTING ROTOR

The rotor (11) is machined to extremely fine limits and from a mated assembly the hydraulic head (10). Near the drive end of the rotor two pump plungers (24) move in opposition within a transverse bore. The plungers are are actuated by shoes (22) which slide in guides machined in the rotor and carry cam rollers (27) operated by the internal lobes of the cam ring. As the rollers pass over the cam lobes they exert pressure on the plungers through the shoes, and perform the pumping strokes. When the rollers have cleared the lobes fuel at metering pressure forces the plungers apart.

An axial passage in the rotor connects the chamber between the pump plungers with a series of radial holes (19), one for each engine cylinder. These are the inlet ports, and as the rotor revolves each registers in turn with the single metering port (9) in the hydraulic head, The passage also connects with the distributing port (18), a single hole in the rotor which registers in turn with a series of radial ports in the hydraulic head, leading to external connections (20) for the high pressure pipes to the injectors.

Maximal fuel setting is decided by the effective stroke of the plungers the outward travel of which can be varied. The shoes (B) - see Fig. 4. 74 - actuating pump plungers (D) are retained in their guides by the top and the bottom adjusting plates (6) and (25) - see Fig. 4. 72 - Ears (F) - Fig. 4. 74 - integral with the shoes register in excentric slots (G) in the adjusting plates (25) - Fig. 4. 72 - The top plate is clamped between the drive plate and the end of the rotor by the two screws (E) - Fig. 4. 74 - securing the drive plate. These screws pass through elongated slots in the top adjusting plate; when the screws (e) are slacken the plates can be moved toagether, being linked by lungs in the top plate which register with slots in the bottom plate.

The outward travel of the plungers is determined by the position of the ears (F) in the excentric slots (G). In Fig. 4. 74 the adjusting plates are set to give the lowest maximum fuel, that is the shortest distance the plunger can travel. This can be increased by moving the plates in a clockwise direction, viewed from the rotor. The plungers are shown on their inlet stroke, and the clearance (C) is the distance the plungers will travel to maximum fuel position.

A cover, secured to the pump body by two hexagon-head screws, provides acces for adjusting the maximum fuel setting.

The adjusting plates are of the type used in light duty pumps.

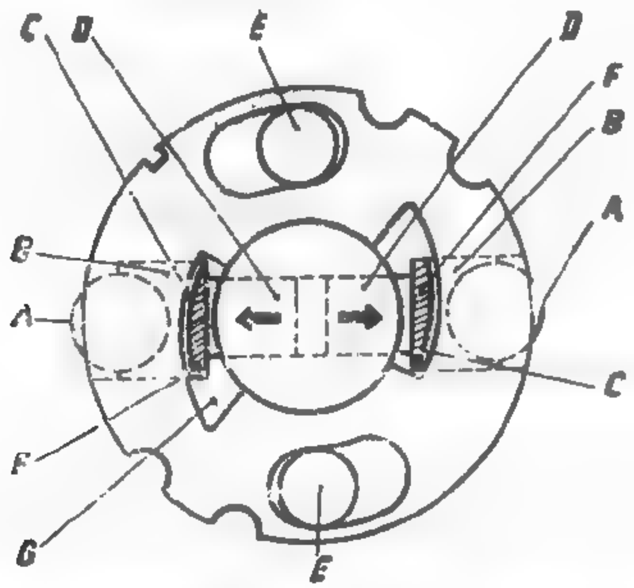


Fig. 4. 74. MAXIMAL FUEL SUPPLY REGULATION

c) HYDRAULIC HEAD

The hydraulic head consists of a barrel shrunk over an inner sleeve and secured in the pump body by three screws that permit only one assembly position. When an automatic advance unit is fitted (as in Fig. 4. 72), the large locating screw is replaced by the head locating fitting (21) - Fig. 4. 72 - which provides a passage for fuel at transfer pressure to the advance piston chamber. The end of the hydraulic head remote from the cam ring is counterbored to provide a recess to house the transfer pump liner(12). A passage from the base of this recess allows fuel to pass to an annular groove in the pumping and distributing rotor and thence to the metering valve chamber (8). Metering valve (7) regulates the flow of fuel through the single metering port (9) which is swept by the inlet ports in the rotor. Between the metering port and the transfer pump are the equally spaced radial outlet ports, which register in turn with a single distributing port in the rotor.

An " O " - ring seal in an annular grove in the periphery of the hydraulic head prevents leakage from the pump boby, and another seal (13) in outer face of the head forms an oiltight joint between head and end plate.

d) TRANSFER PUMP (see Fig. 4. 72)

The transfer pump rotor (14) in screwed into the outer end of the pumping and distributing rotor, the thread being right-hand or left-hand according to direction of pump rotation, so that it tends to tighten when running The transfer pump rotor locates the main rotor longitudinally. A pair of sliding blades in the transfer pump rotor run in the liner (12) located in the hydraulic head.

e) REGULATING VALVE (see Fig. 4. 75 and 4. 76)

The regulating valve performs two separate functions. First, it controls fuel pressure by maintaining a definite relationship between transfer pressure and speed of rotation. Second, it provides a means of by-passing the

transfer pump when the engine is stationary, so that fuel passages in the hydraulic head can be primed.

Fuel at feed pressure passes through a nylon filter (2) - see Fig. 4. 76 a - and the upper fuel passage (9) to the inelet side of the transfer pump. Transfer pressure is exerted through the lower fuel passage (7) to the underside of regulating piston (5) forcing it upwards against the pressure of regulating spring (3).

As pressure rises with increasing engine speed, the piston is forced upwards progressively, uncovering the regulating port (8) and permitting a metered quantity of fuel to flow back to the transfer pump inelt, thus reducing transfer pressure. The effective area of the regulating port increases or decreases as engine speed rises or falls.

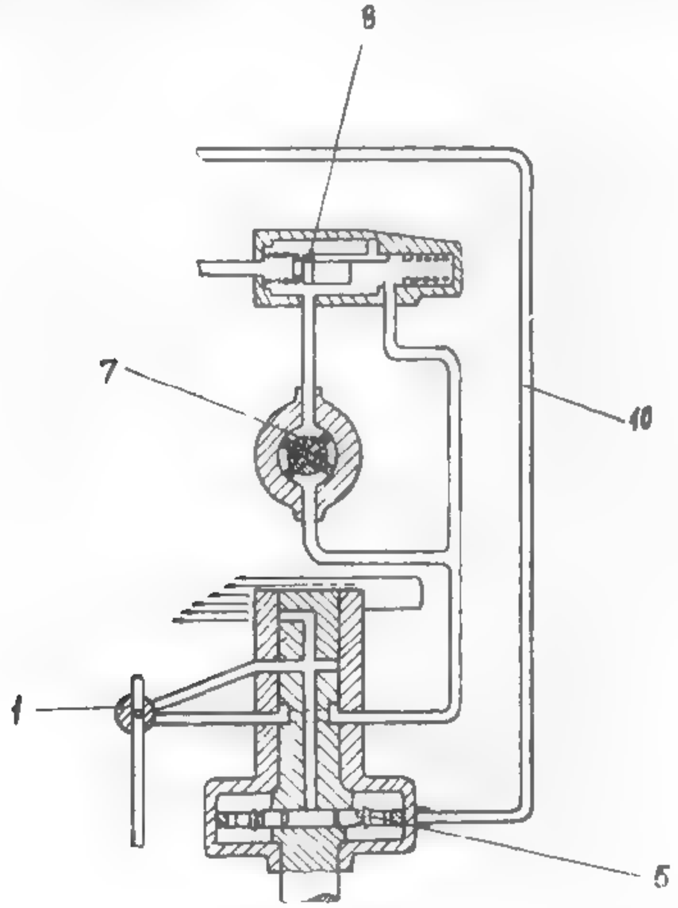


Fig. 4. 75. FUEL CIRCUITS IN THE INJECTION PUMP
1- Metering valve; 2- Injection pump rotor; 3- Hydraulic head sleeve; 4- Cam ring; 5- Pushing rollers; 6- Plungers ; 7- Transfer pump; 8-Regulating valve; 9- Feed line; 10- Fuel return line; 11- Injection high pressure line.

When the engine is stationary, fuel from the inlet cannot pass through the transfer pump into the passages of the hydraulic head in the normal way. Fuel at priming pressure enters the port in valve sleeve (4) and acts on the upper face of the piston (5), which is forced downwards against the priming spring (6), uncovering the priming ports. Fuel then passes through these ports and the lower

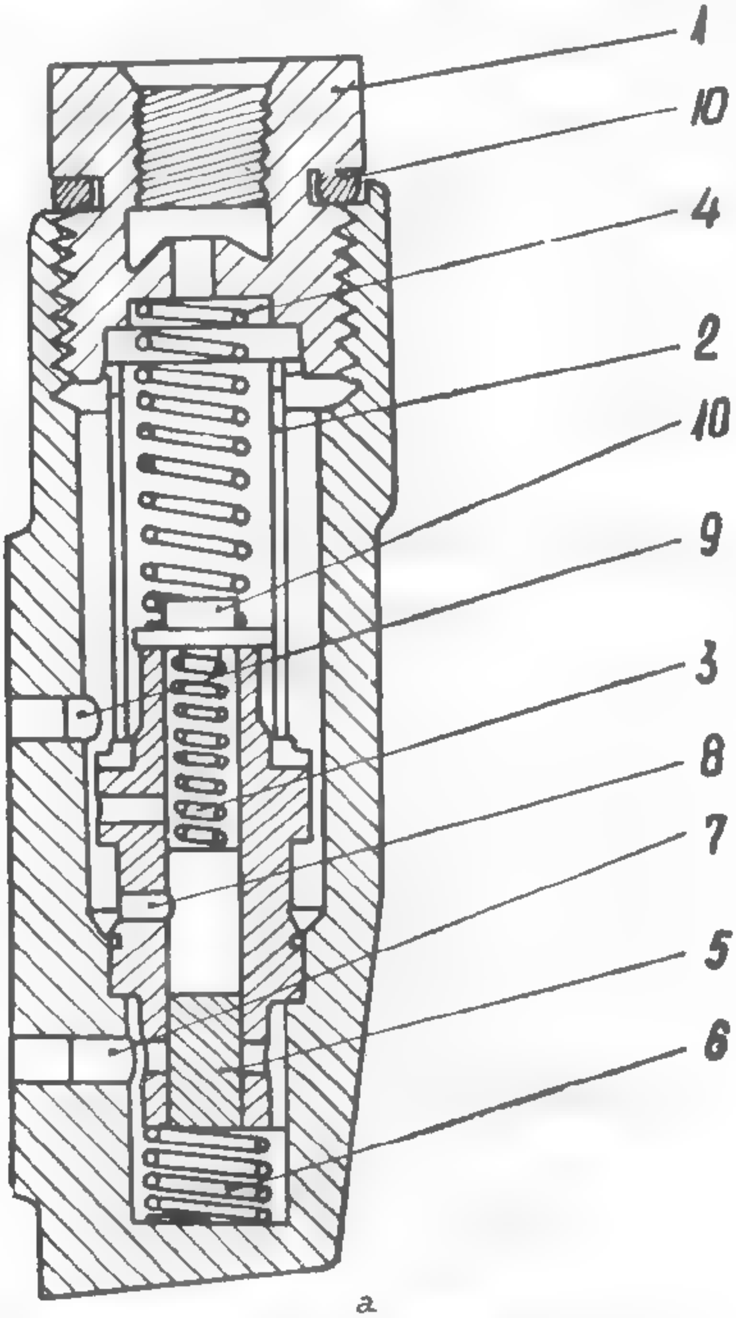
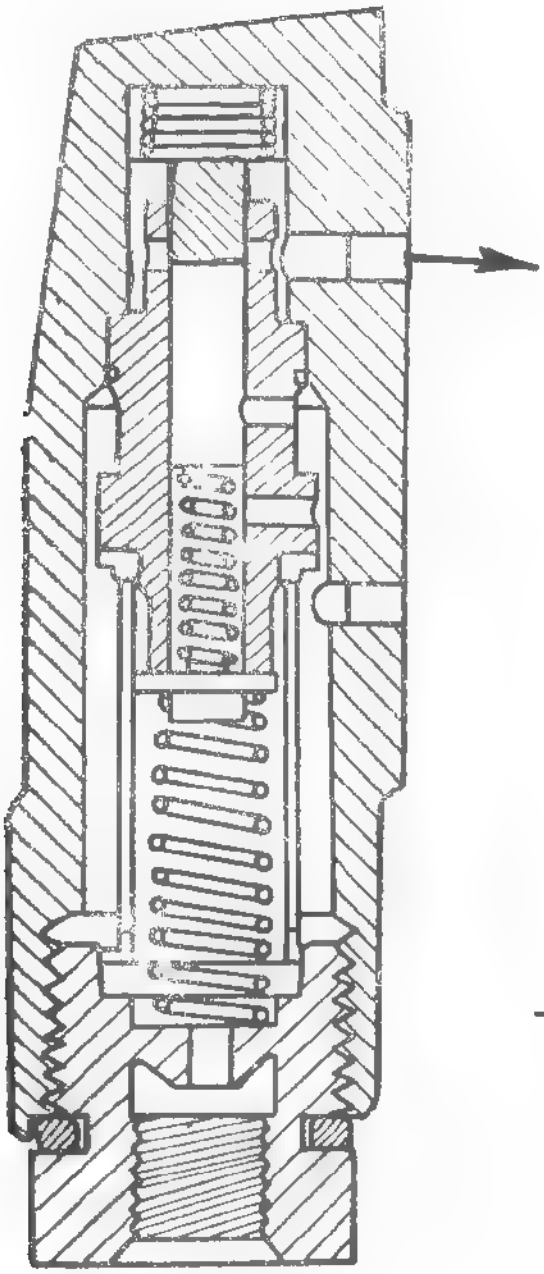
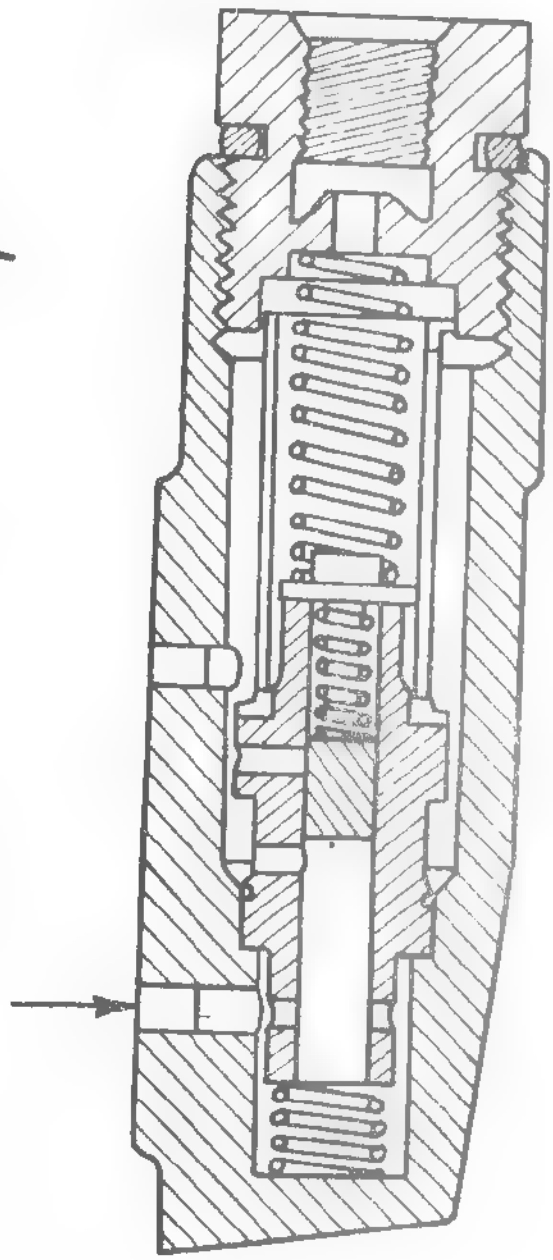


Fig. 4. 76, a - FUEL CIRCUITE IN THE INJECTION PUMP
1- Metering valve; 2- Injection pump rotor; 3- Hydraulic head sleeve; 4- Cam ring; 5- Pushing rollers; 6- Plungers; 7- Transfer pump; 8- Regulating valve; 9 Feed line; 10- Fuel return line; 11- Injection high pressure line.



b

Fig. 4. 76. b
Pos. b) Regulating valve in regulating position



c

Fig. 4. 76, c
Pos. c) Regulating valve in compensating operation

fuel passage (7) to the outlet side of the transfer pump and into the fuel passages in the hydraulic head.

The regulating valve body is an aluminium casting and forms the the end plate cover of the fuel transfer pump and hydraulic head. It is secured on hydraulic head by four unequally spaced screws giving one assembly position only. In this body are located the components of regulating valve (see Fig. 4.76 - pos. a).

In Fig. 4.76 - pos. b - is represented the regulating valve in the priming position. On priming beginning, the fuel, pumped manually, cannot pass through the transfer pump into hydraulic head and forces the regulating piston (5) towards the bottom of its location, overcomes the spring stress and opens the passage for priming the injection pump. Thus the fuel passes through the port (7) into hydraulic head and fills i.e. primes the injection pump.

In Fig. 4.76 - pos. c - is shown the regulating valve in operating position, on compensation.

f) MECHANICAL GOVERNOR OF INJECTION PUMP

The pump governor is of flyweught type, and gives sensitive control at all speeds and loads of engine. The weight retainer (30) - see Fig 4.72 - usually contains six weights (2) - see Fig. 4.77 - and the retainer is fitted on the pump shaft (20). The weights, of special shape, are free in their retainer and can pivot about one edge. As the weights move in and out by centrifugal force, they axially move a thrust sleeve (29) which is a sliding fit on the drive shaft. This movement is transmitted by a linkage to the metering valve, which rotates to control the admission of fuel. The governor control arm (3) oscillates about a fulcrum on the control bracket (18) and is held in contact with the end face of the thrust sleeve by the tension of the spring (19).

The spring loaded linkage hook connects the upper end the governor arm with the control lever which is secured to the metering valve shaft (13) Movement of the governor weights in reponse to fluctuation in engine speed results in movement of the metering, valve and a corresponding change of fuelling.

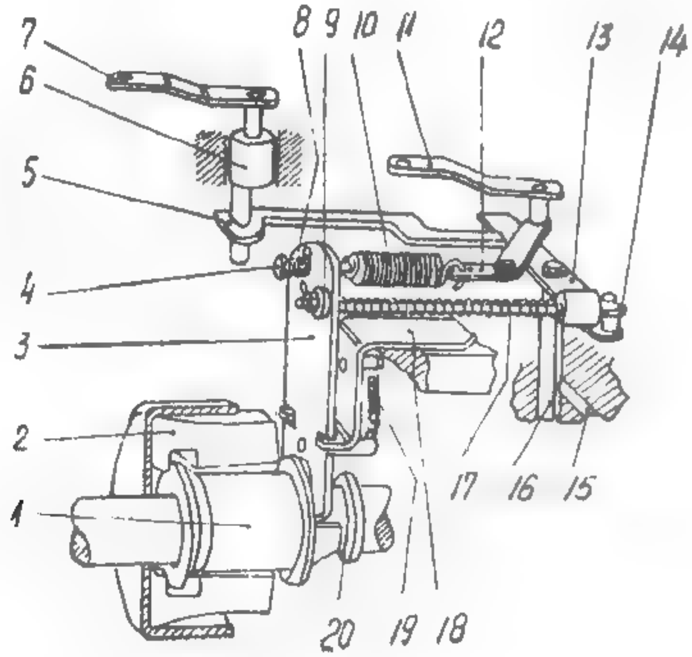


Fig. 4. 77. CONTROL MECHANISM OF MECHANICAL GOVERNOR
1- Thrust seleeve; 2- Governor weights; 3- Governor control arm; 4- Idling spring; 5- Shut-off bar; 6- Excentric shut-off shaft; 7- Shut-off lever; 8- Light idling spring; 9- Ball pivot; 10- Governor spring; 11- Throttle lever; 12- Adjusting link; 13- Control lever; 14- Spring loaded linkage hook; 15- Metering port; 16-Metering valve shaft; 17- Long linkage spring hook; 18- Control bracket; 19- Control arm spring; 20-Injection pump drive shaft.

By the agency of the governor main spring (10) the governor arm can be also actuated by the throttle lever (11). The spring loaded linkage hook (14) is hinged with the governor arm through a ball pivot which allows a free movement of governor arm in keeping with the linkage hook. On the latter is mounted a spring which provides an elastic connection between governor arm and metering valve lever.

The shut-off lever actuates the metering valve (16) by the agency of excentric shut-off shaft (6) and shut-off bar (5). Movement of the shut-off shaft is transmitted to the control lever of the metering valve, rotating the latter to a completely closed position. As the linkage hook is spring-loaded, this movement is independent of governor weight resitance. When the shut-off control is

operated, the spring is compressed, and the end of the linkage hook passes through the governor control arm.

The throttle control lever (11) allows to vary engine running condition. The extreme two pisitions of control lever (11) are limited by two adjusting screws, fitted on governor cover; they are adjusted for indling and full load speed. When the throttle control lever is moved to increase engine speed, the light idling spring (8) is compressed by the guide and tension is applied to the main governor spring (10). This tension acts on the governor control arm and is transmitted to the sleeve, providing a resistance to governor weight movement.

The idling spring (8) gets working only when the throttle control lever is brought in its idling position and when the main governor spring (10) is untensioned. On tensioning the main spring by rotating control lever to higher speed position, the working of idling spring is annulled.

Adjustment of governor characteristics to match the engine features is made at the time of assembly. The governor main spring (10) can be connected to any one of the three holes on link (12).

Also, the idling spring guide (4) can be in any one of the three positions in the governor control arm.

REMARK: On refitting the injection pump the position of both springs should be respected, as they have been before dismantling.

OPERATION OF THE MECHANICAL GOVERNOR

The governor control arm (11) is spring-loaded by the light idling spring (8) at indling speeds, and by main governor spring at higher speeds. For starting, the throttle lever (11) is set at maximum, holding the metering valve in the full fuel position. As soon as the engine is running, the lever is brought back to the minimum setting, and the governor operates in the idling position.

Movement of the throttle lever adjusts the load on the governor control spring, moving the metering valve by means of the control linkage (14), so that more, or less, fuel is admitted to the pump as required. When the selected speed is reached, governor action maintains it within close limits. An increase in engine speed due to reduced load causes the flyweights to move outwarde, whereupon the governor control arm rotates the metering valve towards the closed position, and engine speed drops in response to reduced fuelling. If engine speed falls, the flyweights move inwards, opening the metering valve to increase fuelling and restore the selected speed.

Tensioning of the governor spring causes increased resistance to movement to the grovernor control arm by the flyweights. With greater tension resulting from increased throttle opening, governor control is effective at higher engine speeds.

At idling speed, tension is removed from governor spring and the idling spring gives sensitive control at low engine speeds.

The engine can be shut down instantly by the shut-off lever. The shut-off bar overrides the governor and rotates the metering valve to the no-fuel position, regardless of the position of the throttle lever.

g) CONTROL OF INJECTION TIMING

AUTOMATIC ADVANCE MECHANISM AND ITS WORKING

This mecanism (see Fig. 4.78) gives progressive advancement of injection timing as engine speed increases. Its working is based on transfer pressure variation according to engine speed. By the agency of the this mechanism the transfer pressure variation leads to rotating of the cam ring of the injection pump, i.e. to variation of the injection advance.

The mechanism conists of a body (1), in which the piston (2) is free to slide in body cylinder, under the action of the fuel transfer pressure and back moving springs. Movement of the piston is transmitted by ball ended advance lever (3) of the cam ring to move through an arc within the pump.

A spring, projecting from inside the piston, tends to hold the assembly in the fully retarded position. Fuel oil at transfer pressure enters through a fuel passage in the head locating fitting screw which secures the device to the pump body. Transfer presure on the flat end of the piston moves the latter and the cam ring against the spring pressure. As transfer pressure increases progressively with engine speed, the piston moves along the cylinder, compressing the spring, and move cam ring rowards the fully advanced position. As engine speed decreases transfer pressure falls and spring pressure returns the piston and cam ring towards the retarded position.

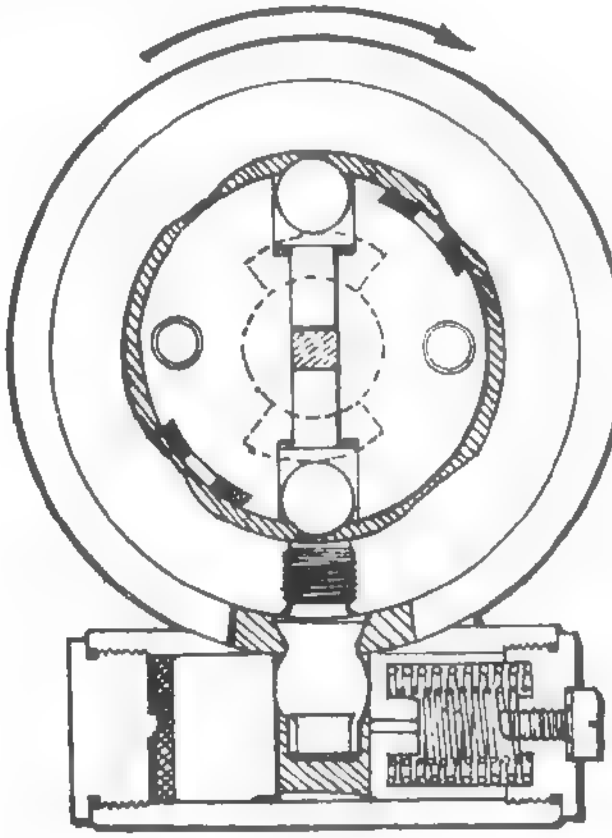


Fig. 4.78. AUTOMATIC ADVANCE MECHANISM
1- Automatic advance mechanism body; 2- Piston; 3- Ball head screw; 4- Starting advance spring; 5- Circlip; 6- Spring plate; 7- Outer piston spring; 8- Inner piston spring; 9- Adjusting shim; 10- End plug; 11- Fuel inlet connection; 12- Cam ring; 13- Spring thrust cover.

The impact of the actuating rollers on the cam lobes at the commencement of the injection stroke tends to move the cam ring towards the retarded position. A non-return valve in the fuel passage in the head locating fitting prevents such movement. As the engine speed falls, normal leakage of fuel past the piston permits the device to return to the retarded position under the action of the spring.

The spring (4) (the lighter one) provides necessary advance on starting engine and at low speed. In the moment when the piston (2) touches the spring plate (6) the action of the spring (4) is annulled. Now, with increasing transfer pressure begin to work the spring (7) and (8). A part of fuel, under transfer pressure, reaches, through manual locking device, into the space between the piston (2) and the plug (11).

On starting engine it is necessary to provide a smaller advance.

It is obtained by annulling the transfer pressure in the advance mechanism, above described, closing the fuel passage by the agency of the advance locking device. In this manner the cam ring modifies ist angular position in keeping with the distributor rotor, so that the injection commencement will retard (the advance decreases).

The circlip (5) limits the travel of the spring plate (6), which is forced by the springs (7) and (8).

On adjusting the advance, on a test bench, through the threaded hole of the piston cap screw (13) is introduced the rod of advance checking device.

h) DEVICE FOR MANUAL LOCKING OF AUTOMATIC ADVANCE

The device for manual locking of automatical advance is shown in Fig. 4.79.

It consists of body (1), having a central port "a", to let fuel pass under transfer pressure, from annular groove zone of the distribuitor rotor to the automatic advance device, through lateral port "b". The port "a" is controlled by the valve, which consists of valve ball (2) and its spring (3). The main role of this valve is to retain fuel to pass from advance device

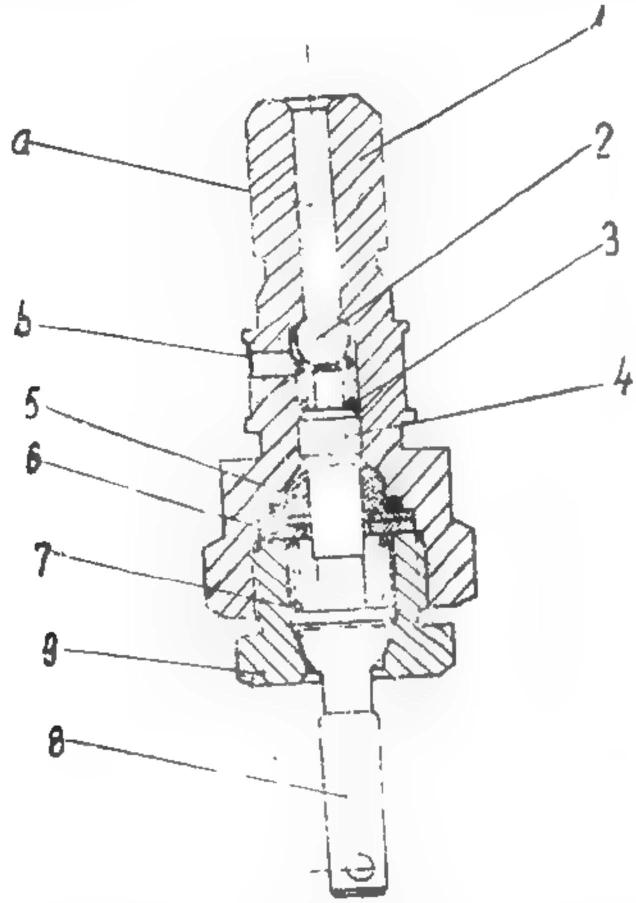


Fig. 4.79. MANUAL START ADVANCE LOCKING DEVICE
1- Locking device body; 2- Valve ball; 3- Ball valve spring; 4- Piston; 5- Sealing gasket; 6- Thrust washer; 7- Control knob spring; 8- Control tilting knob; 9- Assembling nut;

- a) Passage for fuel under transfer pressure
- b) Passage for fuel to automatic advance mechanism.

back to annular groove of distributor rotor, under the action of shocks and rotating tendency of the cam ring, when impacting the rollers actuating the two pistons. The pressure waves, which occur due to these shocks, are hindered to reach the port system of the hydraulic head.

In order to damp the pressure waves, which still are transmitted to the port system of hidraulic head, the pump is provided with a damper with diaphragm.

In the lower side of the locking device body is mounted the piston (4), and the body is sealed with the sealing gasket (5), thrust washer (6) and the nut (9), which presses simultaneously the spring (7).

When the knob (8) has an axial position (vertically), the spring (7) pushes the piston (4) downwards, so that the ball valve (2) controls the central port under the action of the spring (3). This spring is very light, so that it is overcome by low values of transfer pressure, at low speeds.

On starting engine, by lateral pulling of the knob (8) the piston (4) moves upwards, pressing the ball valve on its seat and closing so the fuel passage towards the advance device.

On releasing the knob (8), this returns automatically in its initial, axial position, under the action of the spring (7) and let the ball valve work under the action of the spring 3.

4.2.2.2. TROUBLES REMEDYINGS OF THE INJECTION PUMP

As more important troubles of the injection pump can be remarked
- Inadequate pressures in transfer pump, affecting injection pump output and, respectively, the engine power.
- Injection advance too small or too great, due to inadequate clearances, friction or jammings at the advance control piston or cam ring, as well as to decalibrated springs.
- The maximal pump supply is inadequate, due either to the metering valve or to pump plungers.
- At idling speed the pump supply is insufficient, generally due to the wears of the moving components.
- Faulty shut-off control, due to worn out or jammed internal components.
- Difficult adjusting of the screw for maximal speed, due to damaged or wrong fitted governor spring faulty adjustment of the governor linkage hook, difficult sliding of the governor thrust sleeve.

All these troubles should be remedied by dismantling, cheking and replacing the faulty components of the pump.

Dismantling, refitting, checking and adjusting of the injection pumps require a special training, as well as the using od special tools, devices and checkers. It should be in the repair shop a perfect cleanliness, because the smallest abrasive particle can damage the pump, affect ist correct operation and decrease considerably ist working life!

All the components should be washed with clean fuel oil (Diesel fuel) and assembled without being prior wipped.

On dismantling the pump you should pay greatest attention for obser-ving the mutual positions of different components, in order to deduce their mutual position on refitting and the correct refitting order, so as to perform finaly a correct assembling.

Below are described the important stages on dismantlling and reassembling the pump, in the natural succession.

REMARK: For dismantling and reassembling the DPA injection pumps is necessary a set of tools and checkers specific to this type of pumps. They should be available in every workshop which has the competence to repair these pumps.

OP. 2.0.14.01.0 TAKING INJECTION PUMP DOWN FROM ENGINE

The taking down of the pump hould be performed in conditions of the most possible cleanliness, in order to prevent any penetrating of impurities through the orifices got free after removing the connecting pipes.

- Firstly, remove the control linkages and the feeding pipes.
- Then, remove the oiltight housing (5) -(see Fig. 4.72)- in order to drain the pump. Unscrew and remove the nuts fastening the pump on timing gear cover,together with the lock washers
  On refitting perform operations in reverse oder, tightening the nuts with the torque indicated in the Table XVIII.

OP. 4. 1. 14. 02. 0 D. DISMANTLING REGULATING VALVE WITH THE PUMP TAKEN DOWN FROM ENGINE

- Unscrew the four bolts fastening the regulating valve housing on hydraulic head; remove the housing and the O-ring gasket fitted between both units.
- Remove connecting pipe and overturn the valve housing: all valve components, after removing inlet connecting piece, will slide easily aut of their location.
- After checking, eventually replacing faulty components, refitt regulating valve, performing it in reverse order as on dismantling, and tightening bolts with the torque indicated in the TABLE XVIII.

OP. 2. 0. 14. 03. 0 DISMANTLING REGULATING VALVE WITH THE INJECTION PUMP MOUNTED ON THE ENGINE

- Slacken inlet connecting piece.
- Unscrew the four bolts fastening valve housing on hydraulic head, remove the housing and its O-ring gasket.
- Remove completely inlet connecting piece, overturn the valve housing and let valve components slide easily outside.
- After checking components and replacing the faulty ones, refitt all in reverse order. Correct position of the valve components is clearly shown in Fig. 4. 76.
- Tighten bolts with the torque indicated in the Table XVIII.
- Finaly perform the bleeding of the fuel supply system, acc. to.

OP. 4. 1. 14. 04. 0. COMPLETE DISMANTLING OF THE INJECTION PUMP

- Take injection pump down from engine, acc. to. Op. 2. 0. 14. 01. 0. D.
- Remove oiltight housing, in order to drain completely the pump.
- Fasten the pump in a bench vice, clamping its flange.
- Unscrew the two nuts fastening governor cover.
- Remove governor assy, paying attention for idling spring guide to not let it fall into the pump.
- Undo lock plates und unscrew stud bolts fastening the governor cover and the screw fastening the foot plate of the governor; remove connecting lever and lock washers.
- Remove governor control mechanism together with the metering valve and shut-off lever - by lifting them (see Fig. 4. 77).
- Remove automatic advance device, proceeding so:
  - Fasten the pump in a bench vice, with the advance device upwards.
  - Remove, by unscrewing, the shut-off device.
  - Unscrew nut of the stud bolt fastening the advance device and remove the latter together with its gasket.
  - Remove regulating valve acc. to Op. 4. 1. 14. 02. 0 D.
  - Pemove transfer pump blades and withdraw the transfer pump linter.
  - Hold the drive hub and unscrew slightly the transfer pump rotor, without removing it. Perform unscrewing clockwise.
  - Take down from the pump the damper assy and the bleeding screw bush.
  - Remove from the pump the hydraulic head assy.
  - Unscrew completely the transfer pump rotor and remove the rotor of hidraulic head. On removing it do not let rolers get out from their locations.
  - Hold the drive plate and unscrew the two fastening bolts.
  - Dismantle the top and bottom adjusting plates, the actuating rollers and the shoes from the rotor. Keep each actuating roller with its respective shoes and rollers in a bath of clean fuel oil to protect them from damage and corrosion.

- Retain the twin pumping plungers in the bore of the rotor by two corks inserted in place of actuating rollers.

  REMARK : The pump plungers are mated to the bore and to prevent possible incorrect replacement it is recommended that plungers be retained in the rotor.

- Fit the rotor in the bore of hydraulic head to protect its working surfaces, and secure it by fitting on the transfer pump rotor.

  ATTENTION: The rotor, the seleeve and the plungers of hydraulic head are m a t e d and in no case should be dismated.

- Remove the cam advance screw and remove cam ring.
- Using special pliers remove from the pump body splined drive shaft locating circlip.
- Hold the drive hub with special tool. Slacken and remove the hub securing screw, the support washer and the spring washer, using a special tool.
- Remove from drive shaft the snap ring from the drive side, then remove the shim and withdraw the shaft assy through the pump body.
- Extract the oil seal, using a special tool.
- After checking and replacing faulty components, except these which are not interchangeable, perform the pump refitting, acc. to Op. 4. 1. 14. 05. 0. D.
- After refitting the pump on engine, bleed the fuel supply system, as described in Op. 2. 0. 01. 22. 0. D.

OP. 4. 1. 14. 05. 0 D. ASSEMBLING THE INJECTION PUMP

GENERALITIES

As told above, dismantling, assembling, testing and adjustment of the DPA pumps must be carried out by trained staff, using specialized tools and test apparatus.

Conditions of scrupulous cleanliness must be observed in workshops where pump overhual is carried out. Even the smallest abrasive dust particles

can cause damage to the pump, impair its efficiency and considerably shorten its satisfactory working life.

Dismantled parts should be protected from damage by dust, grif and moisture until zhey are required for assembly. To do this effectively, immerse them in a covered bath of clean, filtered fuel oil. Before assembly, all components must be rinced in clean fuel oil or an approved cleaning fluid, and then assembled wet.

Normal precautions should be taken to protect hands. Where necessary, advice can be obtained from the manufacturar of the fluid used for cleaning and protecting parts. Non-fluffy cloths must be used for wiping hands and under no circumstances must cotton waste be used.

SERVICING INSPECTION

It will be usually be found most convenient and time-saving to inspect individual parts during dismatling, so that replacements can be obtained with the minimum of delay.

The following procedure covers possible defects and the main iteme which may require repair or replacement. The extend of repair necessary depends on service conditions and pump life prior to examination. The requirements listed are the minimum advisible.

Inspect dismantled parts for

1. Damage to internal and external threads, especially on studs, inlet and cutlet connections, and any connections and screws liable to be removed or torque loaded while the pump is on engine.
2. Distorted or fractures springs. Check that all springs quoted in the spare parts list for the respective pump are present. In case of fouling or malfunctioning, ensure that the correct springs are fitted.
3. Scoring, wear, corrosion or any other damage to machined surfaces, including pump body, hydraulic head bore, advance device location, and end plate locating face.

4. O-rings and other seals. Although these items are replaced during re-assembly, care must be taken to use precaution caps, etc. to avoid damage to new seals during. Inspection after fitting assembly is recommended for al seals.

NOTE: The drive shaft and drive plate are lapped together during manifacture, to give a free fit with a controlled backlash. These parts should be kept together; in the event of wear, the complete assembly must be replaced.

INDIVIDUAL ITEMS

Inspect for:

1. Nicked, scratched, worn, corroded or otherwise damaged pump plungers and mated bores.

NOTE : Great care must be taken with pump plunge.s and bores. Plungers must only be removed from the bore if there is a need to inspect them and then, only for a short time required for inspection. Note end of the bore in which plungers are fitted and ensure that each plunger is replaced in the end from which it came. Plungers and bores must be cleaned with clean fuel oil and assembled wet. When the plungers are in the bore of the rotor they must be retained by corks. The rotor must be assembled to the hydraulic head and the complete assembly immersed in a covered bath of clean fuel oil until required for assembly.

2. Wear, craks, nicks, corrosion and, where applicable, deffective threads on the pumping and distributing rotor and the hydraulic head. See that ports and passages in rotor and head are clean and clear.

3. Damaige to rollers and shoes. Examine roller surface and check for free rolling in shoe. Rollers and shoes which have been used should be kept together.

4. Chipped, broken or worn transfer pump blades. Ascertain that blades of correct material are fitted, resin-bonded blades have a groove in the base of the central slot; carbon blades have no such grove.
   Carbon and resine-bonded blades must not be interchanged.

   Handle carbon blades with much care.

5. Wear, corrosion and damage to cam ring.
6. Wear, corrosion and damage to end plate.
7. Valve wear or scoring. Pay special attention to the metering valve and ist bore. Examine the metering valve for loose pin resulting from severe service conditions. Check the regulating valve, also the excess fuel valve and external fuel adjuster, where fitted.
8. Defects in the outlet pressuring valve Shake the assembly and listen for movement of ball or valve. If yes, this denotes a cllapsed valve spring.
   this denotes a collapsed valve spring.
9. Wear in the throttle shaft, the throttle arm and the shut-off lever.
10. Wear, corrosion or damage to the advance device components.
11. Wear and damage to drive shaft, splines and associated parts, especially important on drive plate and quill shaft.
    Check end float if the face of the thrust housing is worn.
12. Wear and scoring of all mechanical governor linkages, shafts, pivot points, arms and weights. Ensure that correct number and tipe of governor weights are fitted.

IMPORTANT

If any part in a mated assembly is damaged or worn, the complete assembly must be replaced. Any component showing signs of fretting, wear, damage, corrosion, cracks or distortion must be replaced, but only with genuine, original parts.

As a general rule, on re-assembling an injection pump all metal or klingerite gaskets should be replaced. The rubber gasket also should be replaced, if they are distorted or damaged and can affect the pump tightness.

Pay special attention for all sealing surfaces for any damages due to handling of components. Pay also special attention for handling and assembling components having grinded or honed surfaces, assembled with very small clearances.

Pay special attention for scrupulous cleanliness in the work shop and perfect accuracy of washing fluids.

On assembly the tightening troque values, given in the Table XVIII should be respected.

Refit drive shaft, assembled with the governor weights, into the pump body, only by means of S 303 special adapter. After introducing the shaft in the pump body, remove the adapter.

ATTENTION: The S 303 adapter is strictly necessary on assembly.

- Fit on the drive shaft the plate adjusting axial play of the drive shaft (allowed play 0.04 - 0.19 mm) and secure with the snap ring, fitted on the shaft front end.
- Using special nose pliers fit in the pump body the circlip, with its flattened side downwards (towards inspection opening).
- Fit in the pump body the cam ring and screw in it ball-headed advance screw.

ATTENTION : The sense of arrow on the cam ring should correspond to that indicated on the pump date plate.

FITTING THE HYDRAULIC HEAD

- Unscrew transfer pump rotor from the pumping and distributing rotor, and remove distributing rotor from hydraulic head.
- Fit on distributing rotor the bottom adjusting plate.
- Introduce distributing rotor into hydraulic head, securing it by screwing counter clockwise the transfer pump rotor.

ATTENTION : Tighten transfer pump rotor by miens of a scoket wrench, without forcing it too much.

Remove the corks protecting the two plungers and check their free sliding in the bore.

- Fit rollers with their shoes so that the shoes ears register in excentric slots of the adjusting plates (see Fig. 4.74).
- Fit top adjusting plate and the drive plate, securing it with its two screws (maximal tightening should be of 4.0 - 4.5 m. daN (29 - 32.5 ft.lbs).
- Fit upon hidraulic head the rubber seal and introduce the former in the pump body, correctily oriented, securing it by screwing in the damper assy and the vent screw bush.

FITTING THE TRANSFER PUMP

- Introduce transfer pump liner; fit blades into the slots transfer pump rotor and check if they slide free in the slots when turning the rotor.
- Fit transfer pump O-ring seal.
- Fit on hydraulic head transfer pump end plate, fastening it with the four screws, so that the end plate pin enters the locating hole of the transfer pump liner
- Now, check the drive shaft rotation, which should occur easily, without any tendency of braking or jamming.

FITTING THE REGULATING VALVE

- Change the injection pump position so that the metering pump bore opening comes upwards.
- Using a tweezers, fit successively, into end plate location, the following components·
- Piston retaining spring (priming spring)
- Regulating sleeve and its gasket
- Regulating valve piston
- Nylon filter
- Regulating spring
- Regulating plug

- Sleeve retaining spring
- Connection washer
- Fuel inlet connection. This one should be tightened using a torque of 4 - 5 m.daN (29 - 36 ft.lbs.)

ATTENTION: The spring guide should be fitted having its face, marked by rings, upwards. Otherwise occurs an overpressure which leads to locking the hydraulic head.

FITTING THE AUTOMATIC ADVANCE DEVICE

- Fasten the pump in a suitable position for fitting advance device
- Fit advance device on the pump housing, together with its hasket, and secure it with the nut of fastening stud bolt.
- Fit by screwing the shut-off device and check correct tilting and reverse movement of the shut-off lever.

FITTING MECHANICAL GOVERNOR

- Fit metering valve into hydraulic head location.
- Fit assembly formed by governor arm and control bracket, with flattened side upwards.
- Fit keep plate and secure it with a screw.
- Fit the two lock washers and the two stud bolts, fasten control bracket with the third screw to pump housing. After that secure by bending the lock plates of stud bolts and screw.
- Introduce linkage hook on metering valve control lever.
- The linkage hook has on it its spring, washers, spacer, pivot ball and securing nuts.
- Fit over the pump housing control cover gasket.
- Fit shut-off bar.

- Fit idling speed guide and light idling spring, fastening the latter to the first hole of governor arm.
- Fit governor main spring, fastening one to idling spring guide and the other to hole Nr. 3 of the link connected with throttle control lever
- Fit governor control cover passing it over two stud bolts and of excentric shut-off shaft passes throgh respective cover bore. The seals of throttle and shut-off shafts should be mounted on both shafts by means of special adapters, in order to protect seals on mounting.
- The space between each two seals should be filled with grease.
- Secure governor cover by tightening the two stud bolt nuts.
- Check again free rotating of the drive shaft.

CHECKING THE PUMP AFTER RE-ASSEMBLY

After re-assembling, all the pumps should be tested for tightness, before testing them on a testing and adjusting stand. A supply of compressed air at about 1.5 bars (21 lb/sq. inch) is applied to the leak-off connection of the pump. The entire pump is then immersed in a bath of clean fuel oil, the air supply turned on, and any leak can be traced by the air bubbles given off. All leaks must be remedied and the pump tested again, before testing and adjusting it on the test bench.

NOTE: 1. In checking for leaks, both before and after the bench test, the minimum period of immersion is 2 minutes.

TABLE XVIII

TIGHTENING TORQUES TO BE APPLIED ON REFITTING THE PUMP

Ref. No.	Unit or component which is to be thightened	Torque to be applied (m.kg)	Torque to be applied (ft.lbs)
1	Regulating valve housing (hydraulic head cover)	0.5 - 0.56	3.6 - 4.0
2	Regulating valve inlet connection	4.0 - 4.5	28.9 - 32.5
3	Transfer pump inlet connection (in the hydraulic head)	0.7 - 0.8	5.0 - 5.7
4	Transfer pressure damper, fastening hydraulic head to the pump body	1.9 - 2.0	13.7 -14.5
5	Vent screw bush, fastening hydraulic head	1.9 - 2.0	13.7 -14.5
6	Advance manual blocking device	3.5 - 3.7	25.3 -26.8
7	Stud bolt fastening automatic advance device on pump body	0.65 - 0.7	11.0 -12.3
8	Automatic advance device plug	2.8 - 3.0	20.2 -21.7
9	Automatic advance device spring cover (plug)	2.8 - 3.0	20.2 -21.7
10	Cap nut of the stud bolt fastening automatic advance device	1.2 - 1.4	8.7 -10.1
11	Cam advance ball-headed screw	3.3 - 3,6	23.7 -26.0
12	Special bolt for high pressure banjo union	3.0 - 3.2	21.7 -23.2
13	Bolts fastening drive plate to distribuitor rotor (1-st tightening)	4.0 - 4,1	28.9-
14	Ditto 2-nd tightening, after a partially slacking	2.8 - 3.0	20.2 -21.7

15	Governor cover stud cap nuts	0, 3 - 0, 4	2, 2 - 2, 9
16	Throttle lever fastening nut	0, 3 - 0, 4	2, 2 - 2, 9
17	Shut-off lever fastening nut	0, 3 - 0, 4	2. 2 - 2. 9
18	Stud bolts fastening governor cover	0, 6 - 0, 8	4. 3 - 5, 8
19	Stud boltes fastening regulating plates on pump housing	0, 6 - 0, 8	4, 3 - 5, 8
20	Screw for fastening governor plate on pump housing	0, 2 - 0, 3	1, 5 - 2, 2
21	Leak-off connection on the pump housing flange	1, 5 - 1, 7	10, 8 - 12, 3
22	Bleeding screw bush on the governor cover	0, 7 - 0, 8	5, 0 - 5, 8
23	Bolts fastening injection pump on engine	2, 28 - 3, 20	16, 5 - 23, 1

OP. 2. 0. 01. 22. D. BLEEDING THE FUEL SUPPLY SYSTEM

Perform this operation as follows·

- Slacken 2 turns the bleeder screw of the first fuel filter (with sediment bowl and actuate the priming lever of the fuel pump untill through the bleeder screw orifice flows oil fuel without air bubbles.
- Slacken the plug of second (micronic) fuel filter and repeat above bleeding operation, tightening then the plug.
- Slacken 2 turns the bleeder plug of the injection pump; unscrew the high pressure connections and crank the engine with strating motor, utnill fuel flows out without air bubbles.
- Tighten the connections, except the bleeder screw of injection pump.
- Start the engine and when the fuel flows out without air bubbles, fit the bleeder screw back and tighten it.

- For testing use only L 4/1 type oil (according to N 30-969 specification of roumanian petroleum rafinery from Ploieşti FIAT CFB/ BOSCH OL61V, SHELL CALIBRATION FLUID, other equivalent oil.
- The data specified in the Table XIX were obtained at an engine temperature of $30^{o}C$ - $35^{o}C$ (86^{o}- $95^{o}F$) and a fuel supply pressure of 0.2 kg/cm^2 (2.84 lb/sq. inch) - on the test bench.
- The of sense pump rotation should be counter clockwise, regarding the pump from ist drive shaft nd.
- The pump should not be operated at a high speed and low supply and the lever for reducing fuel supply should not be actuated for a long time.
- Before beginning the test the pump should be primed; each time when a pressure connection is removed or fitted on the testing equipment or measuring instrument, the pump should be bleeded. If, after having performed the pump will be kept non-fitted on engine, the fuel oil should be kept in it, in order to prevent its wear and corrosion, because the test fuel contains special anticorrosion additive. For this reason it is recommended to not drain the whole fuel quantity from the pump.

If the pump should be stored for a long time it should be filled with special refined mineral oil, incorporating oxidation and corrosion inhibitors.

All open orifices should be covered with plugs (corks); the external components and surfaces should be coated with conservating grease and introduced in a polyethylene bag.

If an injection pump, mounted on the engine, should be conserved for a long time of storage, the pump and the entire fuel supply system should be protected, as followes:

- Shut the fuel supply system main cock and remove from the fuel tank fuel connecting pipe, connecting it to a receiver containing the above specified test fuel oil.
- Let engine run for about 15 minutes, at a speed of 500-800 r.p.m. and stop engine as soon as an oil smoke appears at the muffler rear pipe.
- Now, remove connecting pipe from receiver with test fuel oil and connect it again to vehicle fuel tank.

To connect the pump to test matchine is necessary the following equipment:

- A set of high pressure pipes, to be connected to injectors.
- A set of four KBL 70 S 1 R type injectors.

  ALLA 145 S 448 type automizers, adjusted for a pressure of 226 ± 5 bars (3214.4 lbs/sq. inch).
- A support for the four injectors
- A support for mounting the pump and a flexible drive coupling.
- A speed reduction unit for the test machine
- Inlet and outlet connections, with respective gaskets, for connecting the pressure gange.
- A closed connecting piece which should be fitted in place of the manual start retard device - for tests which differ exteriorly having on orifice more.

  The checker of advance angle should be set to zero.
- Threaded connecting piese, with copper washer, for checking the transfer pump.
- A pressure gauge with nigh pressure connecting pipe.

  The discripition of test connections is given in below exposed test operations.

PRIMING THE PUMP

After connecting the pump to the test machine and after adjusting necessary instruments, perform the pump priming and bleeding, as follows:

- Slacken the two bleeder screws, located on governor cap and on pump housing.
- Connect the supply pipe to the pump outlet orifice, if it has no ball valve; if yes, take down the ball valve, before opening the fuel supply cock, in order to prime the pump.
- Remove the fuel supply pipe from the test machine and connect it to the pump inlet connection. At the same time, connect the pump leak-of pipe to the machine pipe.
- Slacken high pressure connection of the injector.

- Let the pump run at a speed of about 100 r.p.m. Tighten the bleeder screws and the high pressure connection of injectors at the moment when the fuel flows out without air bubbles.
- After pump priming, check tightness on contact surfaces of the high pressure connections, with the pump running and stopped.

CHECKING VACCUM AND SUPPLY PRESSURE OF THE TRANSFER PUMP

For vacuum pressure measuring connect a vacuum-meter connected to the fuel inlet. A vacuum of 400 mm Hg column should be reached in 60 seconds, at a pump speed of 100 r.p.m. For this the two-ways valve should be shut towards the fuel supply and open towards the vacuum-meter.

After measuring the vacuum the bleeding should be repeated.

For checking internal pressure, produced by transfer pump at specific seeds, fit in the place of the screw fastening hydraulic head to the pump housing an adapter, which is connected to the test stand pressure gauge.

By these two tests can be checked the operating efficiency, the wear and tightness of the transfer pump, as well as of the valve regulating the transfer pressure.

The adjusting of regulating valve spring tension is possible by changing the valve inlet connection. Beasides standard dimension this connection is deliverd also in four special dimensions (except the standard one, of 1.1 mm). For identifying these special connections the are marked on the springside by a letter. The marked letter corresponds to a certain dimension of the gasket groove. Thus:

A = 1.3 mm; B = 1.5 mm; C = 1.7 mm and D = 1.9 mm.

CHECKING AUTOMATIC ADVANCE DEVICE ADJUSTING

The test consists in checking operating efficiency of device at different speeds, by reading the corresponding values on the measuring instrument

scale, which is controlled by the piston of automatic advance device.

It is also necessary to check the manual device for advance retard. For this it is necessary to remove the manual retard device which differs from the former, having an orifice more, of small diameter.

ADJUSTING PUMP OUTPUT

The pump output, i.e. fuel delivery is checked at more speeds at full throttle (except the fuel delivery for idling engine speed) and with shut-off control closed.

The maximum fuel delivery is checked with the screw adjusting the maximal speed fully unscrewed and the throttle in maximum load position;

- If fuel delivery is not within the specified limits, adjust it as follows
- Slacken the screws securing the inspection cover and drain the pump.
- Remove the inspection cover.
- Slacken the two drive plate (26) screws. (see Fig. 4. 72).
- Engage special tool with the slot in the periphery of the adjusting plate (25).
- Adjust the plate by lightly tapping the knurled end of the tool.

  The direction in which the drive plate is turned to increase or to decrease fuelling depends on the type of fittedof adjusting plates.

  A displacement of 0.5 mm modifies the fuelling with 1 cm^3.
- After correct adjusting tighten the drive plate screws evenly to the listed troque value (see Table XVIII) using a torque wrench and a special adapter.
- Replace and secure the inspection cover, refill the pump, vent as necessary and check again the maximal fuel delivery. Repeat adjusting until the values are within the specified limits.

NOTE: The screw is introduced into adapter end, while the torque wrench is fitted in the adapter hub. So, the torque wrench and the adapter will be in line when tinghtening the screws, and care must be taken that the wrench does not contact the side of the inspection aperture.

CHECKING THE SHUT-OFF DEVICE

The checking is performed at a pump speed of 200 r.p.m. with the shut-off device closed. A maximal allowed fuel delivery should be of about 4 cm^3/min.

NOTE The pump should be let to operate with the shut-off device closed only for short time periods.

TABLE XIX

CARRYING ON THE TESTS OF INJECTION PUMP

Ref. No.	Kind of test	Pump speed (r.p.m.)	Imposed conditions values
1	Priming the pump	100	- Supply & return of fuel
			- Bleeding the pump & tightening high pressure connections
2	Checking inlet vacuum	100	- A vacuum of 400 mm Hg. col. after max. 60 seconds
3	Transfer pump pressure	100	- Min. 0.8 bars (11.4 lb/in^2)
4	Checking automatic advance control	300	- Beginning with an advance of 0^o
5	Out put control (fuel supply)	1200	- Will be recorded
6	Checking shut-off device	200	- Max. fuel supply: 1 mm^3/s

OP. 2.0.01.23.0 D. CHECKING ENGINE SPEED AFTER FITTING THE PUMP ON IT

- With the engine running at no load speed and minimum throttle, check if the min. no load speed is maintained. If not, adjust idling stop screw. Check engine speed by means of a speedometer.
- A similar checking is necessary for the engine maximal no load speed especially after replacing of units. Let engine in no load running by full throttle and measure iat speed. If specified maximal no load speed cannot be maintained, adjust max. speed adjusting screw and then seal the screw.

OP. 2.1.01.24.0 D ADJUSTING THE INJECTORS

- After cleaning injector components, re-assembly injectors, check and eventually adjust them. For this, perform as follows:
- Actuate the lever for supplying injector with fuel (Fig. 2,51), and read on the pressure gauge scale if the pressure is within limits of 225 - 235 kg/cm^2 (3200 - 3342 lb/in^2).
- Screw in adjusting screw (3) -(see Fig. 2.31)- if measured pressure is below indicated limit or unscrew it, if the pressure is above the specified limit.
- After each adjusting check again injector atomizing pressure.

OP. 2.0.01.20.0 TAKING INJECTOR DOWN FROM ENGINE AND DISMANTLING INJECTOR

The fuel injector for D-127 Diesel engine consists od the injector body (1) - see Fig. 2.31) - (and an atomizer (6), whose needle has four equally speced orifices, with an atomizing angle of 145^0.

- Before removing injectors from their bores, clean thoroughly the whole area around them, on cylinder head, in oder to prevent penetrating of any impurities and dirt into engine cylinders.

Then proceed as follows:

- Unscrew high pressure connecting pieces, as well as the return connections.
- Unscrew nuts fastening injector support an cylinder head
- Remove injectors from their bores
- Remove carbon depozit from injector heads by means of a copper or brass wire brush.
- Dismantle injectors as follows:
  - Fasten injector in a bracket, tighten in a bench vice.
  - Unscrew nut and the cover (2), using special wrenches.
  - Remove the spring and the rod (4).
  - Fasten a support in a bench vi and set atomizer in it; then, using a special wrench, unscrew atomizer fastening nut.
  - Remove injector filter from inlet connection.
  - Wash then all components in clear gasoline.

If the components have no traces of wear or decalibration, refit injector in reverse order.

4.2.3. THERMOSTARTER

The engine is provided with a thermostarter which facilitates the starting of cold engine (in winter). This thermoinjector is located in a support, screwed in the inlet manifold. It is supplied from a supplimentary fuel tank, which in his turn is supplied from the fuel excess pipes, connected to injectors (see Fig. 4.71) .

The thermostarter consists of a body (8) - see Fig - in which is located an electric resistance (5), whose end is so designed as to allow the ignition of the fuel vapour.

The valve body (2) contains a rod (1) which holds the ball valve (3) on ist seat, hindering so fuel penetrating.

When the starter switch is turned in first position the electric current is switched on. It heats the resistance which in his turn heats the rod (1). The latter expande and pushes the ball valve off its seat and the fuel can enter the valve body, where, contacting the hot resistance, it evaporates.

After 15 - 20 seconds the resistance end gets glowing and the developed heat causes the temperature rise of the air from inlet manifold.

By turning the starter switch in the second position, the starter motor is switched on and the engine is cranked. Once the engine starts, the starter switch is let free, returning in its initial position and switching off the current is the electric resistance.

The aspirated air through the inlet manifold cools quickly the valve body. The cooled rod contracts, blocking the ball valve on its seat and the fuel penetrating into thermostarter is stopped.

4.2.4. TROUBLES AND REMEDYINGS OF CYLINDER HEAD

4.2.4.1. DISCRIPTION OF CYLINDER HEAD AND ITS CHARACTERISTICS

The D-127 type Diesel engine for ARO vechicles has two cylinder heads, each of them for two cylinders. They are a casting of special cast iron, provided with hardened valve seats and bores for injectors.

The diameter of valve guides bore is comprised between 13.966 and 13.983 mm. The sinking of valve under cylinder head surface should not exceed 0.7 - 1.1 mm, while the injector are salient with 2 - 2.5 mm.

The dimension figures of the inlet valve should be: D = 40 mm and E = 48.6 mm, while those of exhaust valve are: D = 33 mm and E = 41.6 mm (see Fig. 4.80).

4.2.4.2. REPAIRING OF CYLINDER HEAD ELEMENTS

The repairing of cylinder head concerns the wear of the surfaces cantacting the moving parts, the valve seats - the mounting and sealing surface deformations, the thread wears, etc.

For important repairs it is necessary to take cylinder heads down from engine and then overhaul the assembly.

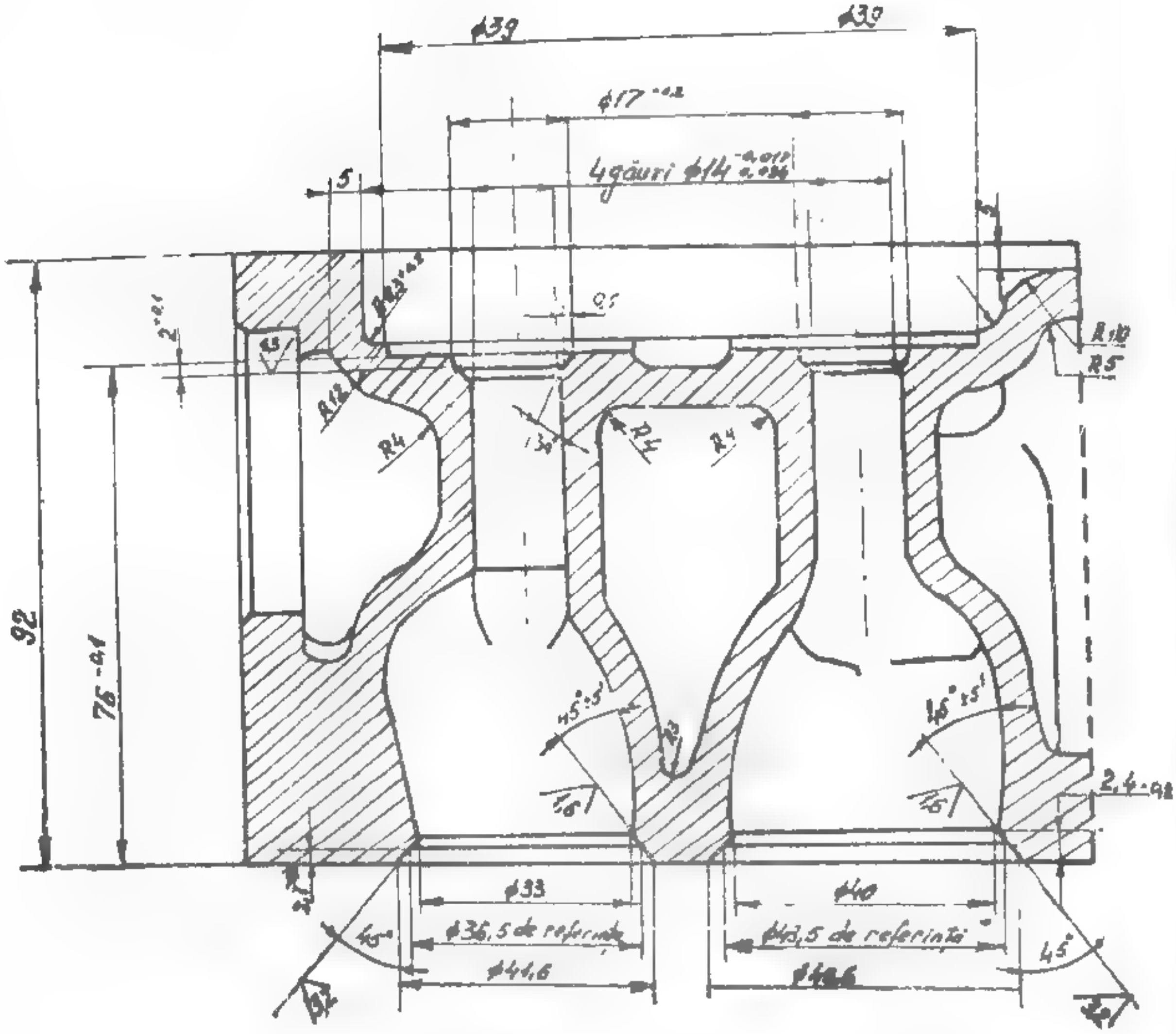


Fig. 4.80. CYLINDER HEAD SIZES FOR THE VALVES

OP. 2.0.01.25.0 D TAKING CYLINDER HEADS DOWN FROM ENGINE

- Drain the cooling system.
- Undo connection between inlet manifold and air cleaner, by removing connection hose from inlet manifold.
- Remove connection between water pump and warm water connection pipe of inlet manifold.

- Remove return connections from the injectors, inclusively from supplimentary fuel tank, mounted above the engine
- Remove high pressure pipes from injection pump and injectors.
- Disconnect the upper mechanical filter from other components and remove it from its bracket, fastened on water collector.
- Take water collector down together with its gaskets.
- Take inlet manifold down, assembled with supplimentary fuel tank and thermoinjector (thermostarter).
- Take exhaust manifold down.
- Remove connecting pipes between the two cylinder heads.
- Remove oil dip stick bracket.
- Take cylinder head covers, acc. to. Op. 2. 0. 01. 16. 1. D.
- Unscrew bolts fastening the cylinder heads on cylinder block

  The reffiting of cylinder heads should be performed in reverse order, performing supplimentarly the bleeding of the fuel supply system, acc. to Op. 2. 0. 01. 22. 0 D, and the filling of the cooling system with fluid.
- On refitting cylinder heads on block, the bolts should be tightened with a torque of 11. 5 - 12. 5 m. daN (83. 2 - 90. 4 ft. lb) in the tightening order indicated in Fig. 4. 81.

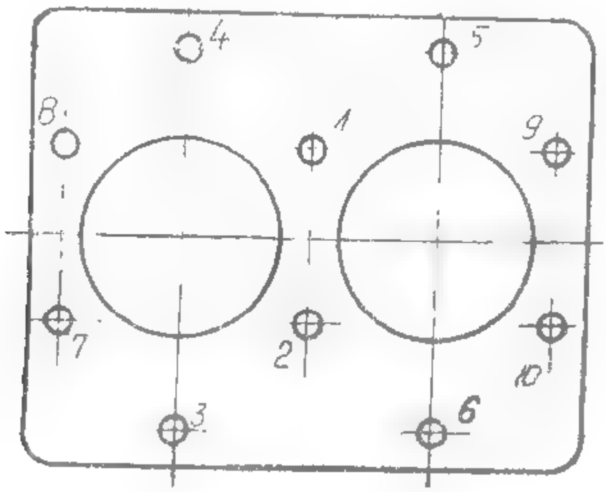


Fig. 4. 81. THIGHTENING ORDER OF CYLINDER SECTION

- Before fitting the cylinder head covers adjust the valve clearances according to Op. 2. 0. 01. 16. 0 D.

OP. 2. 1. 01. 26. 0 D REMOVING CYLINDER HEADS FROM ENGINE TAKEN DOWN FROM VEHICLE

Perform the same stages as on operation 2. 0. 01. 25. 0 D, less taking down the air cleaner and the inlet pipe, as well as the draining and refilling of the cooling system, wich should be performed on taking engine down from vehicle.

OP. 4. 1. 01. 25. 1 D COMPLETE DISMANTLING OF CYLINDER HEADS

- Take cylinder heads down from engine, acc. to Op. 2. 0. 01. 25. D.
- Take cylinder head covers, acc. to Op. 2. 0. 01. 16. 1 D.
- Using a special lever, press down the spring of each valve, pressing upon the upper spring seat, removing the components fastening the spring seat on valve stem end (see Fig. 82).
- Remove the valve, its, spring and the lower spring seat. Before removing the valves, mark position of each valve, in order to fit them in the same place on cylinder head.
- Take down the injectors.
- Take down the rocker arm shaft.
- Depress out the valve guides, if it is necessary to replace them, using a special extractor.
- Perform refitting in reverse order.

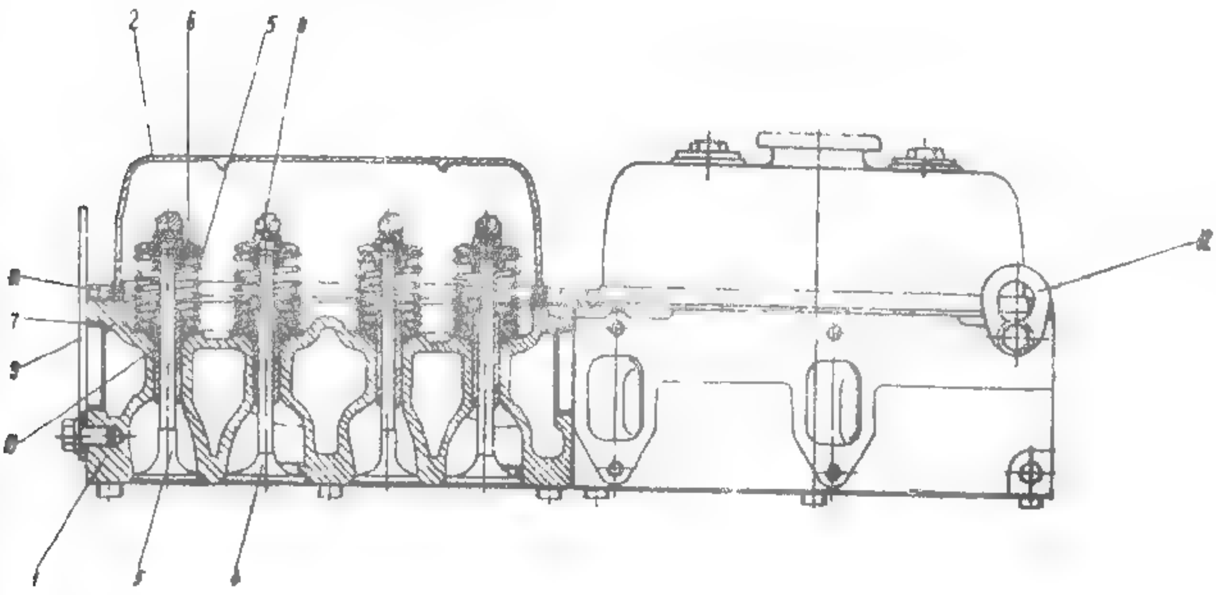


Fig. 4.82. CYLINDER HEAD LONGITUDINAL SECTION
1- Cylinder head body; 2- Cylinder head cover; 3- Exhaust valve; 4- Inlet valve, 5- Valve spring; 6- Valve spring seat; 7- Lower valve seat; 8- Valve disc; 9- Alternator bracket, 10- Valve guide; 11- Cylinder head cover gasket; 12- Engine lifting eye-bolt.

OP. 2.1.01.27.0 D. TAKING ROCKER ARM SHAFT DOWN

- Take cylinder head covers down, acc. to Op. 2.0.01.16.1. D.
- Press down the spring of the valve which is left under rocker arm action in the moment of engine stopping and shift rocker arm aside compressing its spacer spring; then let valve spring free.
- Unscrew bolts fastening rocker arm shaft supports and remove the shaft together with rocker arms.
- On refitting, perform the above stages in reverse order, tightening the bolts with a torque of 2,2 - 2,8 m. daN (16.o - 20.2 ft. lbs).

OP. 4.1.01.27.1 D. DISMANTLING & CHECKING ROCKER ARM SHAFT

- Take down the cylinder covers, acc. to Op. 2.0.01.16.1. D.
- Take down roker arm shaft, acc. to Op. 2.1.01.27.0.
- Unscrew bolts fastening the shaft supports (see Fig. 4.83).

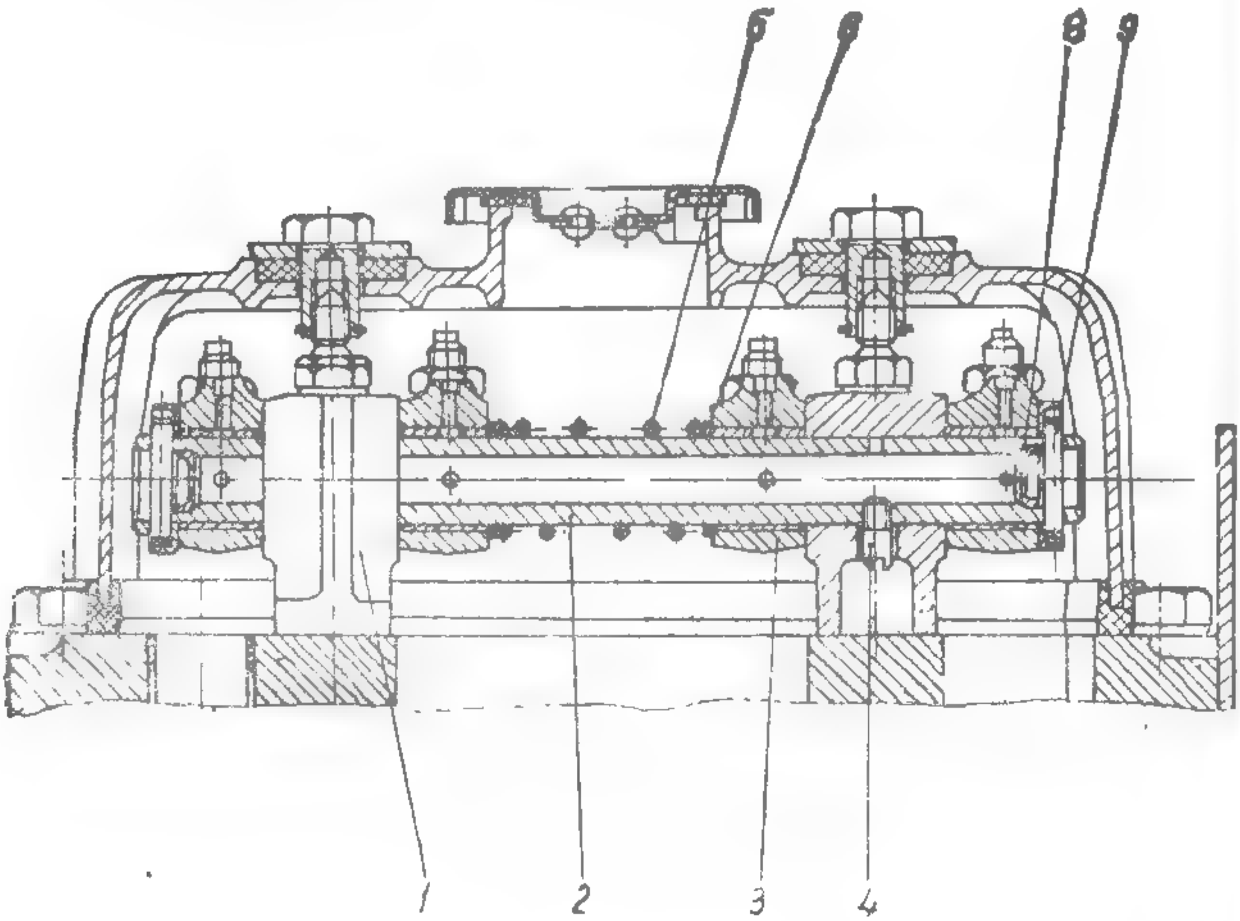


Fig- 4.83. ASSEMBLED ROCKER ARM SHAFT OF D 127 DIESEL ENGINE
1- Rocker arm shaft support; 2- Rocker arm shaft; 3- Rocker arm; 4- Rocker arm shaft locking screw; 5- Spacer spring, 6- Thrust ring; 7- Thrust shoe; 8- Sealing cover; 9- Limiting pin.

- Shift inwards the shaft support, compressing the spacer spring, in order to make the limiting pin (9) free; in this position depress out the pin from rocker arm shaft.

- Draw off over the shaft free all the components titted on shaft.
- Check if the clearance between the shaft and rocker arm bushes is within limits of o. 016 - 0. 052 mm. If not, replace the bushes.

  On refitting rocker arm shaft assy, perform the above stages in reverse order.

OP. 4. 1. 01. 25. 2. D. CHECKING THE CYLINDER HEADS AND COMPONENTS FITTED ON IT

COMPLEXE OVERHAULING

- Take down the cylinder covers, acc. to Op. 1. 0. 01. 16. 1 D.
- Take down cylinder heads from engine block, acc. to Op. 2. 1. 01. 26. 0 D.

  In view of a complete checking of cylinder heads take down from them the valves, valve springs and injectors and clean the mounting surface the valve seats and guides.
- Check flatness of cylinder head mounting surface, passing over it a flat plate, covered with smoke black or Prussian blue, until the prominent areas get visible. These areas should be evened by means of a scraper, if the deformation are very small. If deformation are important, the whole surface should be grinded on a plane grinding machine.
- If the valve seats need a new grinding, the mounting surface of cylinder head can be grinded up to a depth of. max. 0. 5 mm.

In case of performing this grinding, introduce a copper washer of adequate thickness into injector location in order to maintain the same position of injector above cylinder surface. On grinding cylinder head you should take care that the sinking of the valves under cylinder head surface does not exceed 0. 7 - 1. 1 mm.

- Check water and oil tightness of sealing cover and threaded plugs and if they will be found unsatisfactory, replace them.
- After grinding and checking, wash cylinder head with kerosene in order to remove any traces of abrasive material.

The reconditioning of valve seats should be undertaken only after replacing the worn valve guides and after fitting in the valves with rectified stems. The valve seats have to be trued up and should be perfectly concentric to contact surface of valve heads. This precaution is necessary so that the valve should snug down on its seat and ensure both, a good compressing in cylinder and a good vacuum in inlet manifold.

For trueing up the valve seats set cylinder head on a support and use the set of adequate milling cutters and drifts, as follows.

- The grinding disc for removing carbon deposit from exhaust valve seat.
- The milling cutter of 45°, for trueing up inlet and exuast valve seats.

For decreasing of the seat width should be used the following milling cutters:

- 45°20' tapered cutter for inlet valve seat.
- 45°20' tapered cutter for exhaust valve seat.
- 75° tapered cutter for inlet valve seat
- 75° tapered cutter for exhaust valve seat.

VALVES & VALVE GUIDES

Many troubles which occur in the running of the engine result from fualty operation of valves.

For a satisfactory engine performance the valves should ensure a perfect tightness on their seats and have the prescribed clearance in their guides.

If after a thorough cleaning the valves do not provide a perfect tightness on their seats, both the valves and the seats should be trued up, washing them after it, in order to remove any traces of abrasive material.

- If valve guides should be replaced, remove the worn guides blowing them by means of a special drift, from underside of cylinder head - removing guide together with the limiting ring.

If the dimension figure of 0.7 - 1.1 mm, between the valve surface and that of cylinder head is not obtained, use the valves with increased head, i.e.

- inelt valve 43.750 - 44.000 mm
- exhaust valve 36.750 - 37.000 mm

On checking the valve guides, respect the following indications·

- The inner guide surface schould be completely smooth and without any fissures.

  The valve guides should enter their locating bores with press fit; otherwise they should be replaced with oversize new guides.
- After pressing the guides into cylinder head they should be necessarily reamed, in order to ensure necessary clearance for valve stems.

The valve spring can be also removed without cylinder head down from engine block. In this case, on removing each valve spring take special care to not let valve fall into cylinder, bringing firstly respective piston in its inner dead centre.

On refitting valve springs respect the condition that the short pitch coil faces the cylinder head surface.

The clearance between the valve guides and valve stems should be of 0.023 - 0.053 mm.

The outer valve guide diameter, increased for engine overhauling, is of 14.188 - 14.216 mm, so as to secure a press fit of 0.005 - 0.050 mm.

On refitting cylinder head perform the above stages in reverse order.

4.2.5. TROUBLES REMEDYINGS OF THE LUBRICATING SYSTEM

4.2.5.1. DESCRIPTION OF THE LUBRICATING SYSTEM

The engine lubrication is a pressure one by the agency of an oil gear pump, driven by the camshaft. The pressure relief valve is incorporated in the pump housing. It begins to open at a pressure of 3.6 bars (51 lb/sq.inch).

The oil is filtered by the agency of:

- A strainer filter, fitted in the suction pipe in the oil sump.
- A main filter designet for the whole pump supply, provided with a paper filtering element and an overpressure valve which allows the by-passing of oil if the filter is clogged.

The engine is filled with oil through oil filler caps, located on cylinder head covers.

The transmission ratio between the camshaft and lubricating pump is 1 : 1.

The clearance between the oil pump shaft and 1st bearing bush is 0.016 - 0.055 mm.

The clearance between the pump gear flanks should be 0.100 mm.

The axial play of the pump gears should be 0,025 - 0.126 mm.

The radial clearance of the pump gear inside the pump housing should be 0.060 - 0.170 mm.

The spring of the by-pass valve has a free length of 45 mm and a length of 30.5 mm, when loaded with 9 daN (20 lbs.).

The oil filter is delivered assembled with the housing which constains the filtering element and outer gasket. It is fitted by screwing on a bracket, fastened on engine.

4.3. MECHANICAL VEHICLE DRIVE

4.3.1. PRESENTATION OF THE VEHICLE DRIVE

The rotary movement and the drive torque are transmitted from the engine by the agency of a mechanical clutch, hydraulically controlled. The clutch assembled with the crankshaft is dynamically balanced. Mounting and balance position are marked by digit "O" punched on flywheel and clutch cover.

Further, the gear box, assembled with transfer box (or only the gear box, for 4 x 2 variant), transmits the rotary movement and the drive torque, by the agency of longitudinal propeller shafts to the rear and front differentials. From hear the movement and the torque reaches the drive wheels. The front axle wheels are provided with the free rolling mechanism (only 4 x 4 formula), which allows undoing the drive transmission from the front wheels.

On request the ARO vehicules are delivered with power take off, wich can be provided also with a drive pulley.

4.3.2. TROUBLES & REMEDYINGS OF THE CLUTCH

4.3.2.1. CLUTCH MAIN FEATURES

The clutch is of single dryplate type hydraulically controlled, provided with an elastic system, fitted with coil spring as torsion damper. The clutch disc conveys crankshaft rotation to main drive shaft of gear box. It contains the friction disc, made of two ferrodo clutch linings, assembled by riveting to driven disc.

Assembled friction disc is linked to clutch hub through coil spring.

The siprings are introduced in ports of hub flange and of friction disk. On transmitting engine torque, coil spring are compressed in keeping with torque. Compression of springs is limited by margins of indentations in hub flange abutting spacer bolts.

The clutch cover which conveys rotation of flywheel to pressure plate, has three rectangular ports in which the projections of the pressure plate enter.

The pressure plate is forced against the friction disc by nine clutch springs, through heat insulating washers. On clutch cover, three clutch release clevies are fastened, to which the clutch release levers are mounted with three lever shafts. Clutch release levers are also linked to pressure plate through agency of bearing needles. Adjusting screws are fitted on ends of release levers. With these screws one can adjust clearance between them and throwout sleeve.

The clutch control is hydraulic. On pressing down the clutch release pedal the clutch slave cylinder receives brake fluid under pressure and its piston rod pushes the clutch release fork. In his turn the fork pushes the throwout sleeve, fitted with a thrust bearing, which pushes the three clutch release levers, withdrawing the the clutch pressure plate against the nine springs.

In this manner the clutch is released.

Now, on releasing the clutch pedal, the nine springs push the pressure plate and the clutch is again coupled with engine.

- The clutch pressure plate should have a smooth and even surface.

On checking its flatness, on an even plate, the 0.08 feeler gauge should not pass. The surface should be even, without scratches or unevennesses. The faults are remedied by grinding.

- The clutch if deformed, can be trued up, so that on checking flatness of its mounting surface a 0.25 mm feeler gauge should not pass.

- Each of the nine clutch springs shuld have a free length of

$51^{+1.5}_{-0.5}$ mm.

- Tension of springs when mounted (compressed to 38-7 mm) should be

- For red marked spring 39 - 41 kg (86 - 90 lbs.)
- For yellow marked springs 41-43 kg (90 - 95 lbs.)
- At same clutch, only springs of same sorting group (red or yellow) should be mounted, so as to obtain an uniform pressure on friction disc.

4.3.2.2. TROUBLES REMEDYING OF THE CLUTCH

The clutch can get out of order during its operation, as a result of important wears or damaging of some components. These troubles show themselves by anormal noises on engaging and disengaging the clutch or by clutch skidding under or by incomplete gearbox disengaging. All these troubles can be easy diagnosed by the vehicle driver.

It is recommended to performe the clutch overhauling in a "Service" station, being necessary a lot of special tools, devices and checkers.

Untimely wears, as quick wear of friction discs or of thrust bearing can be a result of incorrect vehicule operation, by maintaining clutch pedal pressed down for long periods or by frecvent engine overloads.

Anormal noise on disengaging clutch can result from incorrect adjusted clearance of throwout sleeve (see Op.2.0.01.22.1), or unlubricated, worn out or damaged thrust bearing or from the seizing existing between the clutch release levers and the throwout sleeve, (see Op. 2.1.16.04.0).

In case when the noise appears on relasing clutch pedal check the thrust bearing for wear rate or condition of gearbox transmission shaft If clutch skiddings occur on quick load variation, the cause should be the lubricant which accidentally penetrated upon the friction disc (see Op 2. 1. 16. 05. 0) or decalibrated clutch springs or incorrect adjusting of clutch relase lever adjusting screws.

In case when the clutch does not disengage the gearbox the cause of trouble can be in the clutch control hydraulic system (in the main cylinder) - (Op. 2. 0. 19. 03. 0), or in the clutch slave cylinder (Op. 2. 1. 16. 09. 0) or in the flexible clutch control line, which should be replaced (Op. 2. 0. 19. 04. 0).

It can also happen that the clutch does not disengage the gearbox due to excessive play of clutch control pedal (Op. 2. 0. 19. 02. 0) or due to the clutch disc which is wobbling (Op. 2. 1. 16. 10. 0) or the friction ring is broken and fallen between clutch components and needs to be replaced (Op. 2. 1. 16. 06; 0), or due to difficult sliding of the trouwout sleeve over the gearbox shaft slots. (Op. 2. 1. 16. 11. 0).

4. 3. 2. 3. CLUTCH TROUBLES REMEDYING

OP. 4. 1. 16. 02. 0 TAKING CLUTCH DOWN FROM VEHICLE

The clutch should be taken down only then, when all other sources of troubles have been investigated and settled. The clutch taking down should be avoided because the clutch housing is machined at the same time with the engine block (being assembeld together), in order to secure the perfect coaxility of the crankshaft main bearing axis and that of gearbox transmission shaft, as well as for the reason that the clutch have been staticaly and dynamicaly balanced, being assembled with the crankshaft.

If nevertheless the clutch taking down gets indispensable, before performing it mark the mutual position between steel sheet clutch cover and the flywheel, on which the former is fitted.

Perform taking down as follows:

- Remove transmission tunnel cover, from inside of vehicle.

ake down both rear and front propeller shafts from transfer box drive flanges.

- Disconnect flexible speedometer shaft and reverse speed signaling cable.
- Unscrew bolts fastening gearbox to the clutch housing.
- Hold the gearbox (ATTENTION ! It weights 60 kg. i.e. 132 lbs !) and draw it backwards, with much attention and let it not hang while still attached to the primary transmission shaft, becuase it can be distorted or the clutch disc damaged.
- Remove the gearbox.
- Disengage clutch erlease fork from hydraulic piston rod and ramove clutch fork retracting spring.
- Take down the clutch housing lower cover.
- Mark mutual position between clutch cover and flywheel.
- Unscrew successively bolts fastening clutch cover to flywhell, turning the crankshaf in order to make each bolt accessible.
- Remove the clutch cover and friction disc.
- After remedying the troubles, performe on refitting, the above stages in reverse order.
- Adjust clearance between throwout sleeve and the three adjusting screwe. (Op. 2.0.17.02.o).

OP. 4.1.16.02.1 TAKING CLUTCH DOWN FROM ENGINE WHEN THE LATTER IS TAKEN DOWN FROM VEHICLE

As far as possible avoid to take clutch housing down from cylinder block, because it is fitted to block in the manufacturing factory by means of special devices, so that the bore at the clutch housing back, in which the gear box is centered, is perfectly coaxial to the main bearing axis.

Likewise avoid dismantling the clutch, as far as possible, as the crankshaft, together with the parts assembled on it have been dynamically balanced by the manufacturing plant.

In case that it will be strictly necessary, it may be done with as taking down clutch housing and crankshaft, by proceeding thus:

- Take down retracting spring.
- Take down clutch release fork.
- Take down assembled gear transfer boxes.
- Take down clutch housing cover.
- Unscrew in turn and progressively, bolts securing friction disc and clutch assembly, after having prior marked the mutual position of assembled parts.

OP. 2.1.16.03.0. REPLACING CLUTCH THRUST BEARING

- Take down clutch control, acc. to Op. 2.0.16.02.1. (release fork)
- Take gearbox down from vehicle, acc. to Op. 2.0.17.01.2.
- Remove from transmission shaft and plate neck the throwout sleeve, assembled with thrust bearing.
- Set throwout sleeve on an adequate sleeve and depress the bearing with a hydraulic press or use a bush, aplying on it light blows.
- Wash the throwout sleeve in an organic solvent, so as to remove any impurities.
- Press into throwout seleeve the new thrust bearing (2) - see Fig. 4.32
- Smear inner bore of throwout sleeve (1) with the grease UM 175 (or equivalent) and fit the sleeve over the gearbox transmission shaft end plate neck, after having cleaned the latter, removing old grease.
- On refittig throwout sleeve perform the stages in reverse order
- Tighten bolts with torques indicated in the Table XVI.

OP. 2.1.16.04.0 REMOVING SEIZING FROM CLUTCH RELEASE LEVER ADJUSTING SCREWS

- Take down clutch control, acc. to Op. 2.0.16.02.1

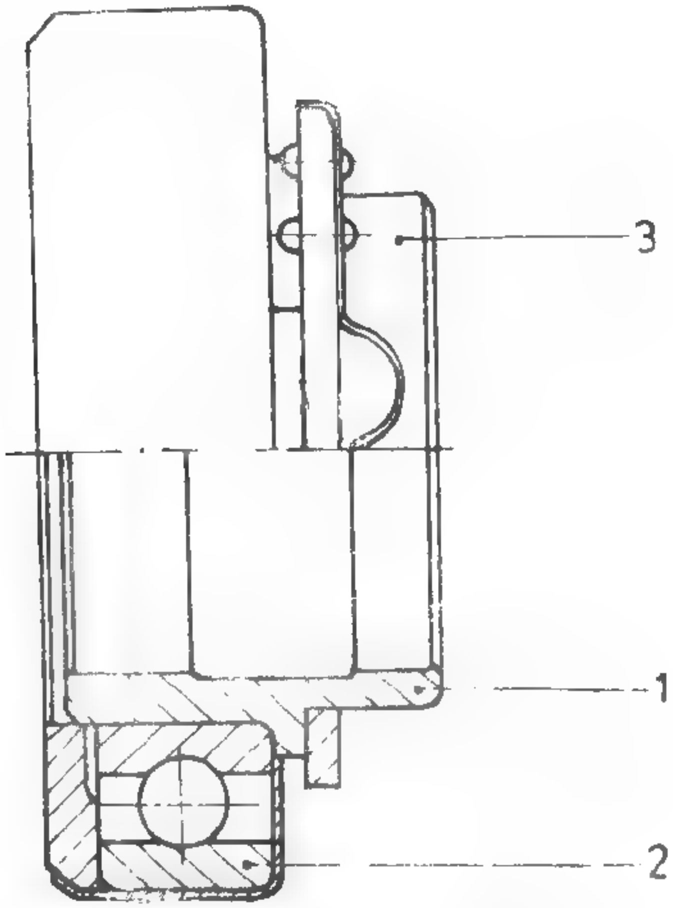


Fig. 4. 92. CLUTCH THROWOUT SLEEVE
1- Throwout sleeve body; 2- Sealed throwout bearing;
3- Clutch release fork clamp.

- **Take down gearbox from vehicle, acc. to Op. 2. 0. 17. 01. 3.**
- **Take down throwout sleeve and replace the thust bearing, acc. to Op. 2. 1. 16. 03. 0.**

  Take down the cluch from engine flywheel, acc. to Op. 4. 1. 16. 02. 0
- **Remove seizing traces on clutch release lever adjusting screws, the operation can be performed when the screws are fitted on levers or removed from them**

- Refitt adjusting screws on the three release levers and adjust them so that the distance between the top of screws and the clutch cover mounting surface on the flywheel reaches 54 mm (see Fig. 4. 93).

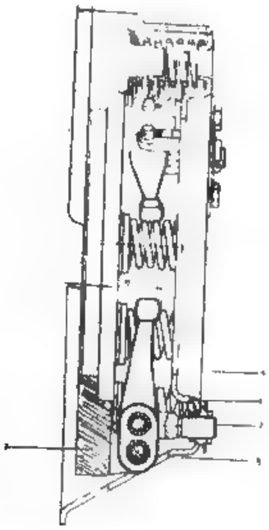


Fig. 4. 93. ASSEMBLED CLUTCH
1- Clutch cover; 2- Clutch pressure plate; 3- Clutch release lever clevis fastening bolt; 4- Release lever; 5- Needle bearing withaut outer race; 6- Clutch pressure coil spring; 7- Thermoinsulating washer.

Lock adjusting screws in this position by caulking the taper hole of adjusting screw ends, using the S 1 special chisel.

- Further, refitt clutch components, performing the above stages in reverse order. On refitting the clutch center clutch disc by the means of D 4 spelined centering drift.
- Finaly adjust throwout clearance acc. to Op. 2. 0. 19. 02. 0.

OP. 4. 1. 16. 05. 0 REMOVING LUBRICANTS FROM CLUTCH FRICTION DISC

- Take down clutch control, acc. to Op. 2. 0. 16. 02. 1.
- Take down gearbox from vehicle, acc. to Op. 2. 0. 17. 01. 3.
- Remove the clutch from flywheel, acc. to Po. 4. 1. 16. 02. 0.

Make free the friction disc, wash it in strong organic solvent and remove thoroughly all traces of lubricants; then dry the disc.

- Check on the warm disc for traces of lubricant, using a sheet of paper. If no more lubricants traces will be found, refitt the clutch performing the above stages in reverse order.
- Tighten bolts with the torques specified in the Table XVI.
- Adjust clearance of throwout sleeve, acc. to Op. 2. 0. 19. 02. 0

OP. 2. 1. 16. 06. 0 REPLACING CLUTCH FRICTION DISC

- Take down clutch control, acc. to Op. 2. 0. 16. 02. 1.
- Take down gearbox, acc. to Op. 2. 0. 17. 01. 3.
- Remove clutch assy from engine flywheel, acc. to Op. 4. 1. 16. 02. 0.
- Replace the clutch friction disc by a new, original disc, after having checked it for wobbling, using the V 114 wobbling checker.
- On refitting friction disc center it by means of D 4 centering drift. Perform above stages in reverse order, on refitting the disc.
- Tighten bolts with the torques specified in the Table XVI.
- Adjust clearance of throwout sleeve, acc. to Op. 2. 0. 19. 02. 0.

OP. 2. 1. 16. 07. 0 REPLACING THE NINE CLUTCH SPRINGS

- Take down clutch control, acc. to Op. 2. 0. 16. 02. 1.
- Take down gearbox, acc to Op. 2. 0. 17. 01. 3.
- Remove clutch assy from engine flywhell, acc. to Op. 4. 1. 16. 02. 0
- Using a compressing device with screw, press clutch cover against the friction disc and unscrew bolts fastening the three clutch release clevises (see Fig. 4. 93).
- Make gradually free and let expand the clutch springs (6).

- Check springs, one by one, for decalibrating and replace unadequate springs, having the same group colour as unreplaced springs.
- On refitting the clutch performe the above stages in revese order.
- Adjust clearance of throwout sleeve acc. to Op. 2. 0. 19. 0. 2.

OP. 2. 1. 16. 08. 0. CLUTCH ADJUSTING

After mounting lay the clutch on the adjusting device 7820 - 4004.

Actuate the device and tighten the clutch adjusting nuts so that the adjusting size is $52{,}3^{+0{,}4}$ mm.

After adjusting assure the adjusting screws.

Perform the static balance by drilling out the pressure plates. The number of holes - as necessary.

Maxim allowed unbalance: 30 gram.

OP. 2. 1. 16. 09. 01 CHECKING AND EVENTUALLY REPLACING THE PISTON CUP OF HYDRAULIC CLUTCH CONTROL CYLINDER

- Remove clutch control, acc. to Op. 2. 0. 16. 02. 1
- Remove slave cylinder boot and piston pushing rod.
- Remove snap ring from slave cylinder, by means of S 102 special nose pliers and then remove piston with its cup.
- Replace the worn cup only with original one.

  Before refitting ,smear components with brake fluid.
- Fit the cup on the piston using S 110 mandrel.

- Reassembly slave cylinder and refitt clutch control on engine block, performing the above stages in reverse order.
- Adjust clearance of clutch throwout sleeve, acc. to Op. 2. 0. 10. 02. 0.

OP. 2. 1. 16. 10. 0 CHECKING CLUTCH DISC FOR WOBBLING

- Remove clutch control, acc. to Op. 2. 0. 16. 02. 1
- Take down gearbox from engine block, acc. to Op. 2. 0. 17. 01. 3.
- Remove clutch assy from engine flywheel, acc. to Op. 4. 1. 16. 02. 0
- Check clutch disc for wobbling, using the V 114 checker, and friction disc for flatness. If flatness deviation will be found, replace the friction disc and true up the clutch disc by grinding.
- Perform clutch refitting in reverse order, tightening bolts with the torques specified in the Table XVI.
- Adjust clearance of throwout sleeve, acc. to Op. 2. 0. 19. 02. 0
  On centering clutch friction disc use the D 4 centring drift.

OP. 2. 1. 16. 11. 0 CHECKING AND REMEDYING THE SLIDING OF THE CIUTCH DISC HUB OVER THE GEARBOX TRANSMISSION SHAFT

- Take down clutch control, acc. to Op. 2. 0. 16. 02. 1.
- Take down gearbox from engine block, acc. to Op. 2. 0. 17. 01. 3.
- Remove clutch assy from engine fylwheel, acc. to. Op, 4. 1. 16. 02. 0.
- Check sliding of clutch disc hub over the slots of gearbox transmission shaft. If it slides with difficulty, because of dirt, the slots should be washed and cleaned with organic solvent and, after that, smeared with U 100 fresh gresh grease (or equivalent one). If after cleaning the slots the sliding of hub is still difficult (with great friction) it means that the transmission shaft has been distorted and should be straightened or replaced (see "Remedying of the gear box" - § 4. 3. 3. 2).

- On refitting performe the above stages in reverse order and finaly tighten bolts with torgues indicated in the Table XVI. On fitting the friction disc, center it with D 4 centering drift.
- Adjust clearance of throwout sleeve, acc. to 2. 0. 19. 02. 0.

OP. 2. 0. 16. 02. 1 TAKING DOWN CLUTCH CONTROL FOR REMEDYING CLUTCH UNITS

- Remove from the clutch control slave cylinder the flexible connecting hose of hydraulic. clutch control system.
- Remove retracting spring from clutch release fork.
- Remove clutch release fork from clutch cover, using S 2 special lever.
- After having remedied and refitted the clutch, refit clutch control performing the above stages in reverse order.
- Finaly adjust clearance of throwout sleeve, acc. to Op. 2. 0. 10. 02. 0.

4. 3. 3. TROUBLES & REMEDYINGS OF GEARBOX TRANSFER BOX ASSY. AND ITS VARIANTS

4. 3. 3. 1. DESCRIPTION OF GEARBOX TRANSFER BOX WITH THEIR VARIANTS

The gearbox is of mechanical type with three shafts, providing four forwards and one reverse speed. (see Fig. 4. 94).

All four forwards speeds have synchromesh engagement. Synchronization is obtained on cones and guide pins (4. 95).

The transfer box is mechanical and contains a reduction gear, in formula 4 x 4 doubles the drive torque on all four wheels.

On special require the ARO vehicles can be equipped with a power take off transfer box.

The gearbox & transfer box assembly weighs .65 kg (144 lbs.) and, when equipped with power take off, 75 kg (165 libs.).

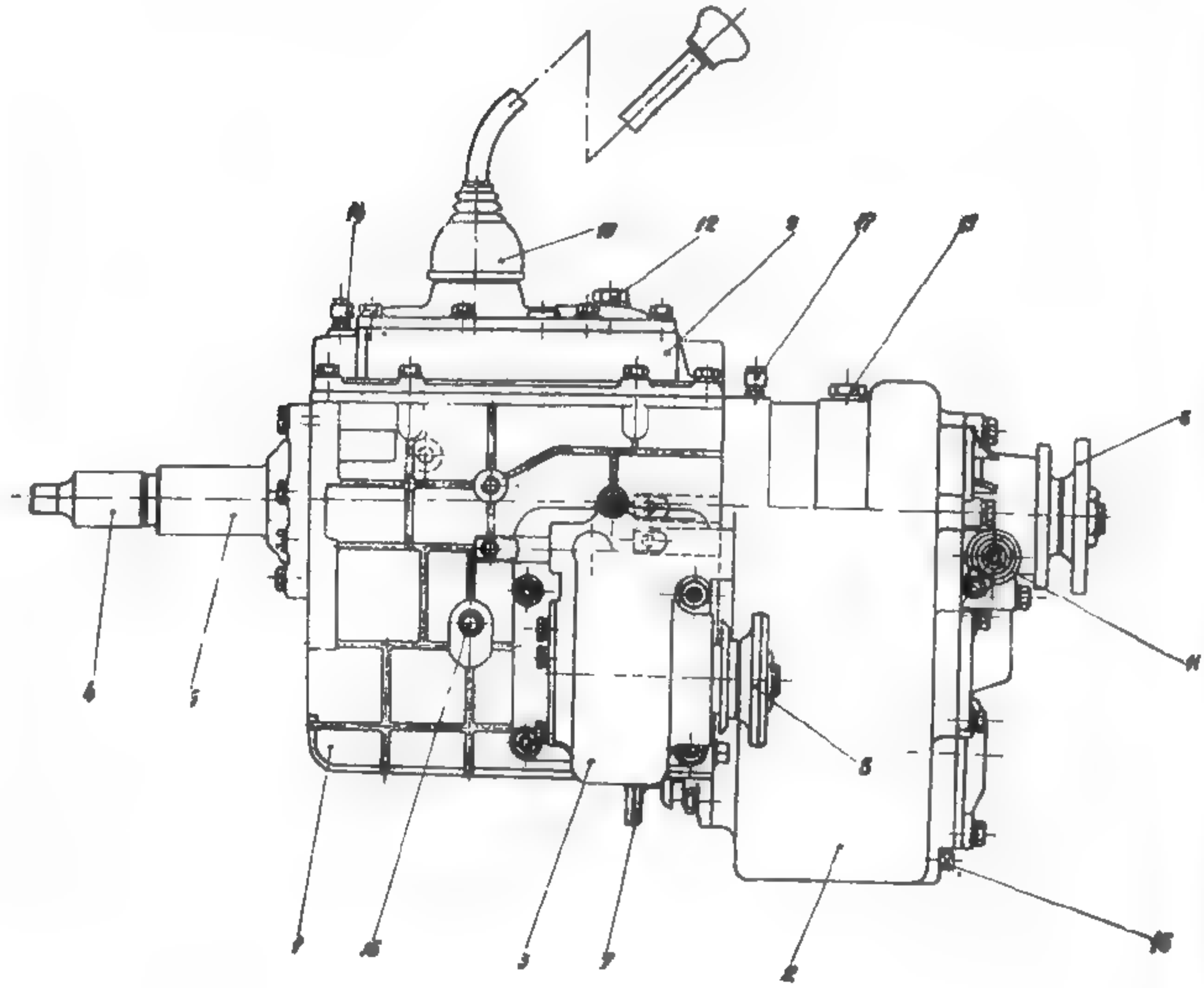


Fig. 4. 94. GEARBOX ASSEMBLED WITH TRANSFER BOX AND POWER TAKE-OFF

1- Gearbox; 2- Transfer box with reduction gear; 3- Power take-off; 4- Transmission shaft; 5- Transmission end plate; 6- Rear propeller shaft connecting flange; 7- Front propeller shaft connecting flange; 8- Power take-off propeller shaft connecting flange; 9- Gearbox lower cover; 10- Gear shift lever; 11-Speedometer drive shaft; 12- Gearbox oil filter plug; 13- Transfer box oil filler plug; 14- Gearbox housing bleeding valve; 15- Gearbox oil plug; 16- Transfer box oil drain plug; 17- Transfer box bleeding valve.

The gearbor assembled with transfer box is able to transmit to **propeller shafts** an output power of 60 kW (82 H. P.) at a speed of 4200 r. p. m. **and a drive torque of** 17 m. daN (123 ft. lbs). at a speed of 2500 r. p. m.

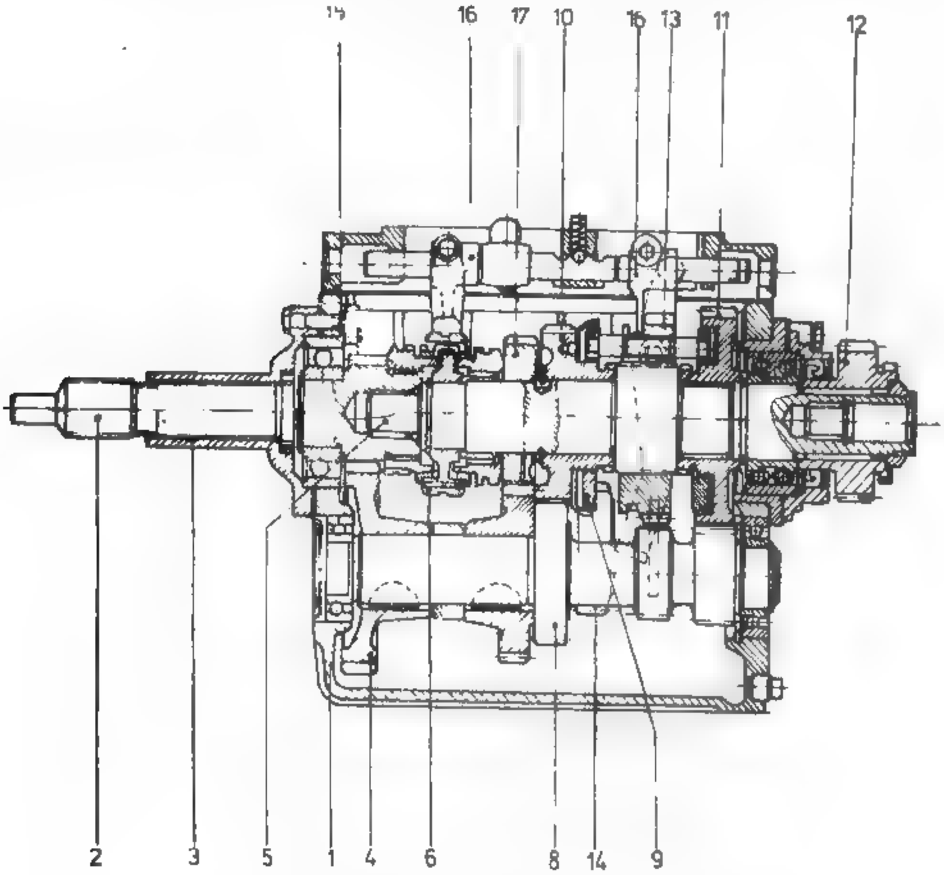


Fig. 4. 95. GEARBOX LONGITUDINAL SECTION
1- Gearbox casing; 2- Transmission shatf; 3- Transmission shaft end plate; 4- Constant mesh gear; 5- Main shaft; 6- Mechanism synchronmesh (3 rd & 4 its band); 7 - 3 rd mainshaft gear; 8- Layshaft; 9- Mechanism synchronmesh (1 st & 2 nd band); 10- 2- nd mainshaft gear; 11- 1- st mainshaft gear; 12- Transfer box outer pinion; 13- Driven pinion; 14- Reverse idler gear; 15- Gear box cover; 16- Shitf fork.

The gearbox reduction ratios are the following:

- **First speed**	1 : 4. 644
- **Second speed**	1 : 2. 5317
- **Third speed**	1 : 1. 561
- **Fourth speed**	1 : 1 (through-coupling)
- **Reverse speed**	1 : 4. 7948

The transfer box reduction ratios are the following:

- First step 1 : 2.127
- Second step 1 : 1

The power take-off is coupled to reverse speed pinion (Z = 13) on the intermediate shaft and has a redu tion ratio of 1 : 3, 100.

The flexible shaft, driving the speeoometer (having a constant equal to 1000) is fitted on transfer box housing and coupled to the gear shaft which drives the rear axle, having a transmission ratio of 2 : 1.

The gearbox & transfer box assy is fitted on the clutch housing being centred on the transmission shaft end plate (3) - Fig. 4. 95 - and fastened to clutch housing by four stud pins.

The transmission ratio of rear and front propeller shafts is equal to 1 : 1, so that the speed of both propeller shaft is equal to the speed of the gearbox mainshaft.

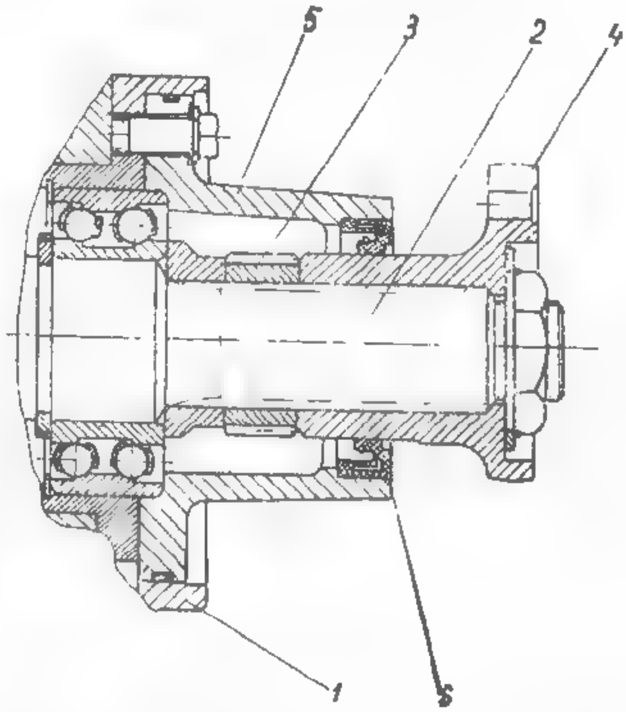


Fig. 4. 96. GEARBOX OUTLET FOR VEHICLES WITH SINGLE DRIVE AXLE (4 x 2)

1-Transmission case; 2-Main shaft; 3-Speedometer drive gear; 4- Rear propeller shaft connecting flange; 5- Main shaft end plate; 6- Annular oil seal.

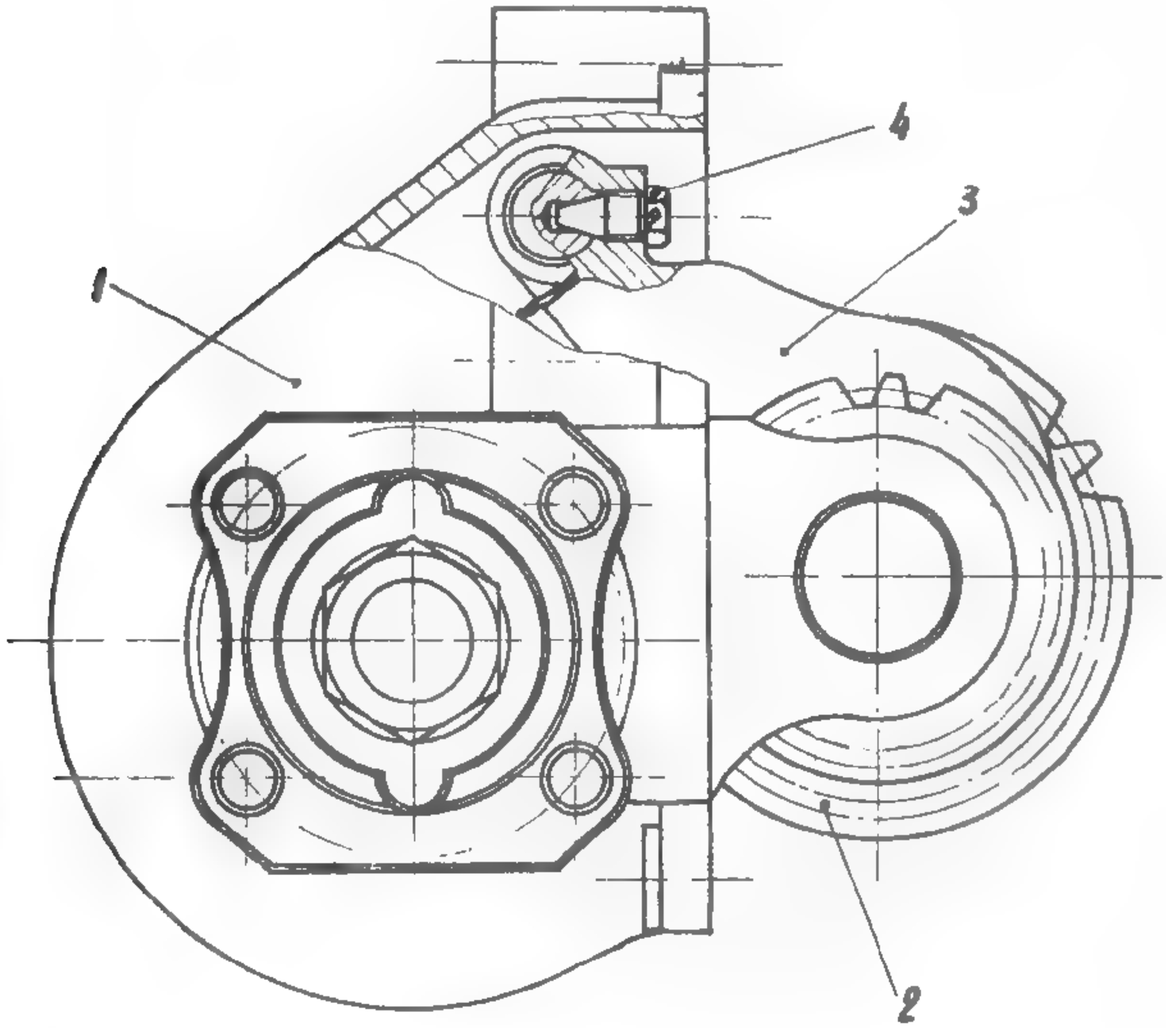


Fig. 4.97. GEARBOX POWER TAKE-OFF
1- Power take-off housing; 2- Gearbox layshaft connecting pinion; 3- Power take-off coupling fork; 4- Bolt securing coupling fork on shift shaft.

The gearbox consists of the following components:

- Gearbox casing which is an luminium casting and constains the gear system. (1)
- Gearbox cover (15) on which are fitted the gear shift cover with shifting forks and gear shift lever.

The transfer box has an aluminium alloy housing and contains the gear system for engaging cu disengaging the front wheel drive and reduction gear.

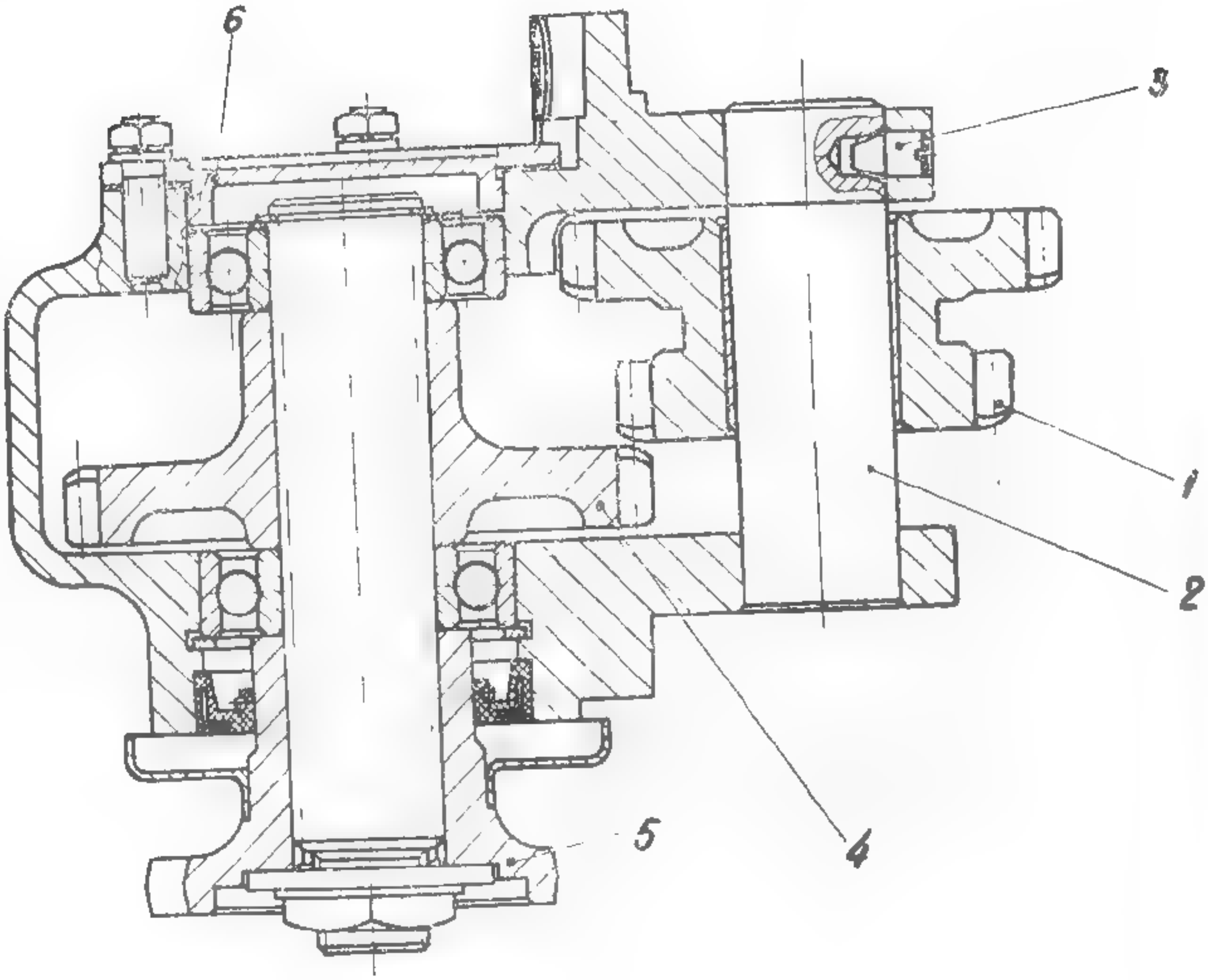


Fig. 4.98. POWER TAKE-OFF GEAR
1- Sliding pinion; 2- Intermediate shaft; 3- Shaft locking screw; 4- Power take-off drive pinion; 5- Power take-off cadran shaft connecting flange; 6- Ball bering rear cover.

Normally the vehicle should be driven only by rear wheels. The front wheel drive should be engaged only when absolutely necessary, i.e. when traversing muddy or sandy country, step gradients, snow, etc. In case that the vehicle is equipped only with rear wheel drive, the drive output from gearbox is that which is shown in Fig. 4.96 (formula 4 x 2).
On special request the power take off, is mounted on gearbox transfer box assy, so as it is shown in Fig. 4.97. The power take off is coupled to reverse speed

sliding gear, as shown in the Fig. 4.98. The clearance between sliding gear and its shaft should be within the limits 0.04 and 0.103 mm and the radial run out of the sliding gear toothing should be of about 0 05 mm.

On the gearbox housing is fitted the gear shift cover (see Fig. 4.98).

4.3.3.2. THOUBLES & REMEDYINGS OF THE GEARBOX TRANSFER BOX ASSY

The gearbox and transfer box troubles generally consist of wear of bearings, sealing rings, synchronizing rings or shift forks damaging, all these bringing about gear system damaging.

TABLE XX

Possible troubles	Necessary remedyings
- Uncontrolled gear throw out occurs in one of the gear steps <u>Cause:</u> Worn synchronizing rings, worn guide pins of the II-III step, or warped forks, large axial play between gears on main shaft, pronounced wear of teeth.	Replacing of worn or damaged gearbox components.
- On changing speeds the gears do not mesh, due to brocken pilot pin, distorted forks, seized sliding gears on shafts or brocken forks	Replace the pilot pin lever, straighten the forks, eliminate the jamming of sliding gears by fine grinding or honing without exceeding the allowed tolerance limits - or replace the worn or damaged components.

- Abnormal operation noises that may be due to fork friction on pinions, worn out pinions or bearings or insufficient lubricant.	Straighten the distorted forks, replace worn pinions and bearins, top gearbox with fresh, adequate oil.
- Untransmission of drive torque, due to Woodruff key shearing, which fasten the constant mesh gear on layshaft.	Replace Woodruff key.

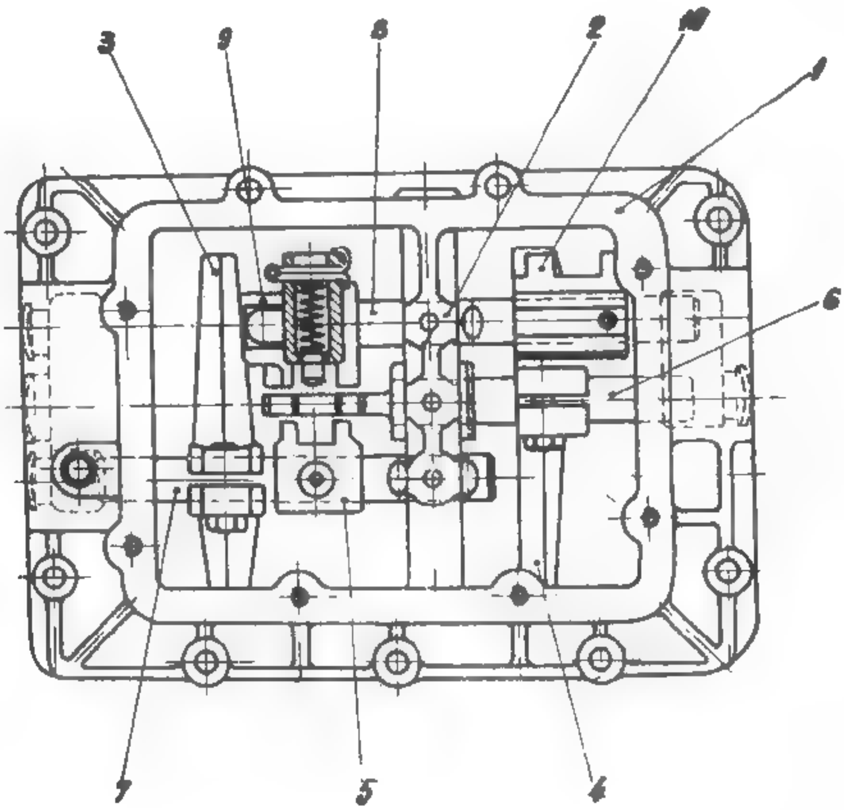


Fig. 4.98. GEARBOX GEAR SHIFT COVER
1- Gear shift cover; 2- Locking ball & coil spring locatinon; 3- 3 rd & 4 th shitf fork; 4- 1 st & 2 nd shift fork 5- 3 rd & 4 th band shift lug; 6- 1 st & 2 nd selector shaft; 7- 3 rd & 4 th selector shaft; 8- Reverse idler shaft; 9- Reverse speed shift lung; 10- Reverse speed shift lever.

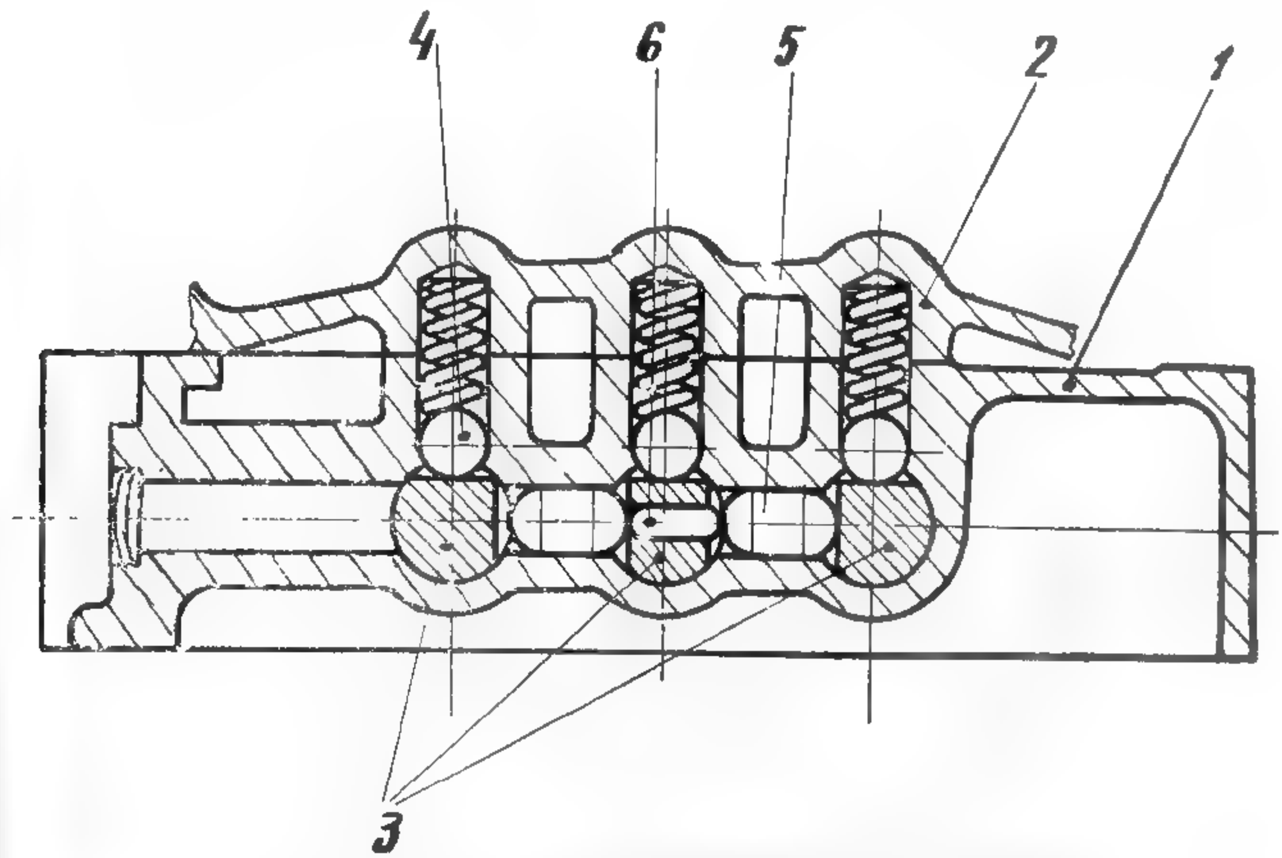


Fig. 4.100. FORK SHIFTING SHAFTS' LOCKING SYSTEM
1- Gearbox lower cover, 2- Gear shift cover; 3- Shift fork shafts; 4- Locking balls & springs; 5- Retainers; 6- Guide pins.

4.3.3.3. TROUBLES REMEDYNGS OF TRANSFER BOX CONTROL

The transfer box control has the role to engage the front wheels as well as the reduction gear.

During vehicle operation may occur troubles as: uncotrolled throw out, blocking, etc. which are caused by excessive wear of selector shaft and selector forks. For remedying these troubles the transfer box should be dismantled. (see Fig. 4.105 and 4.106 and 4.107).

4.3.3.4. TROUBLES AND REMEDYINGS OF TRANSFER BOX

The transfer box has the role to distribute the gearbox mainshaft movement and the drive torque to both vehicle axles, when operating out road, in heavy road conditions.

The troubles which may occur in the transfer box are: noises, blocdngs, etc.

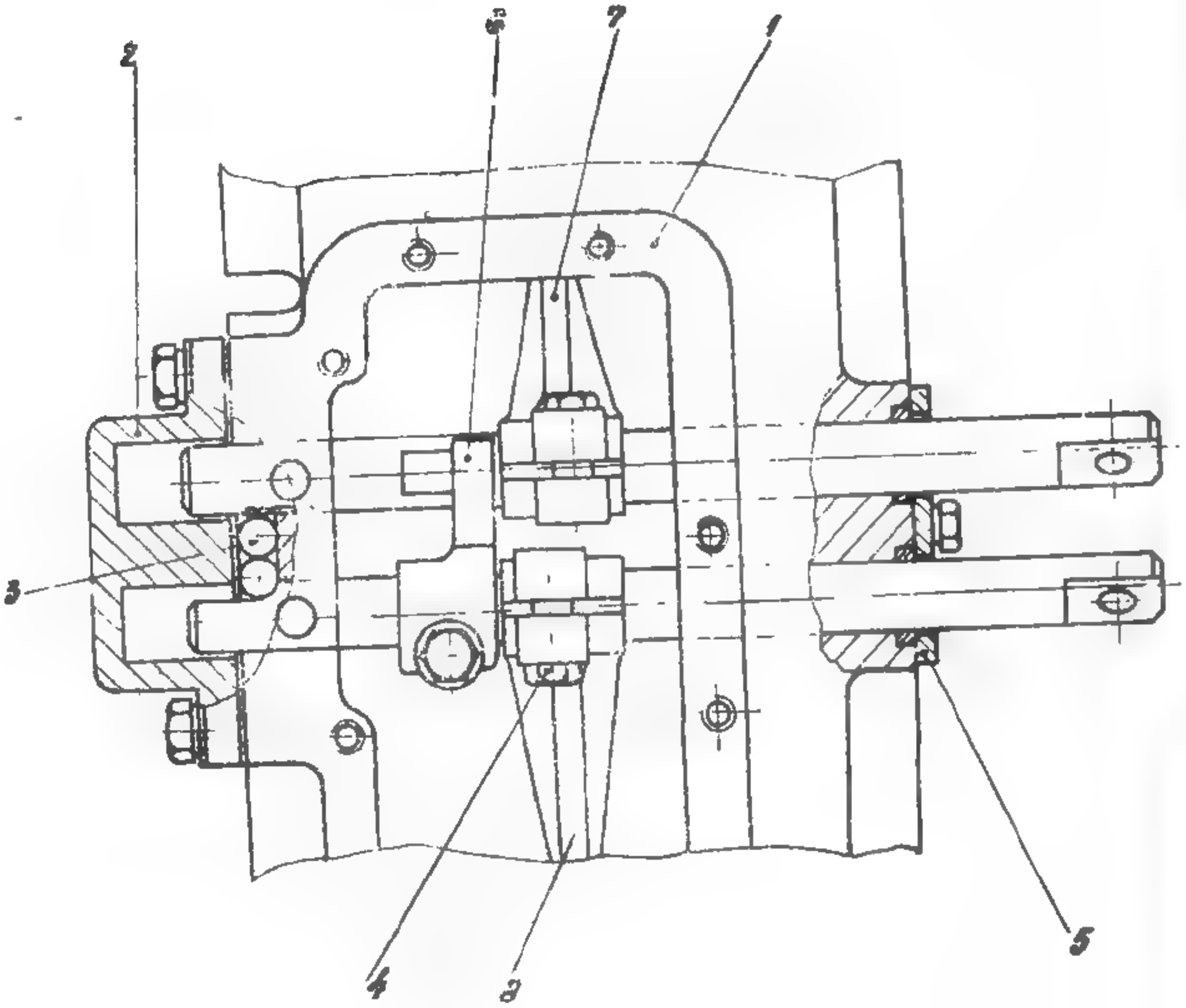


Fig. 4.105. TRANEFER BOX CONTROL
1- Transfer box upper cover; 2- Control shafts' cover; 3- Locking balls; 4- Screws locking forks on shafts ; 5- Sealing rings' plate; 6- Reduction gear limit stop; 7- Reduction gear coupling fork; 8- Front propeller shaft coupling fork.

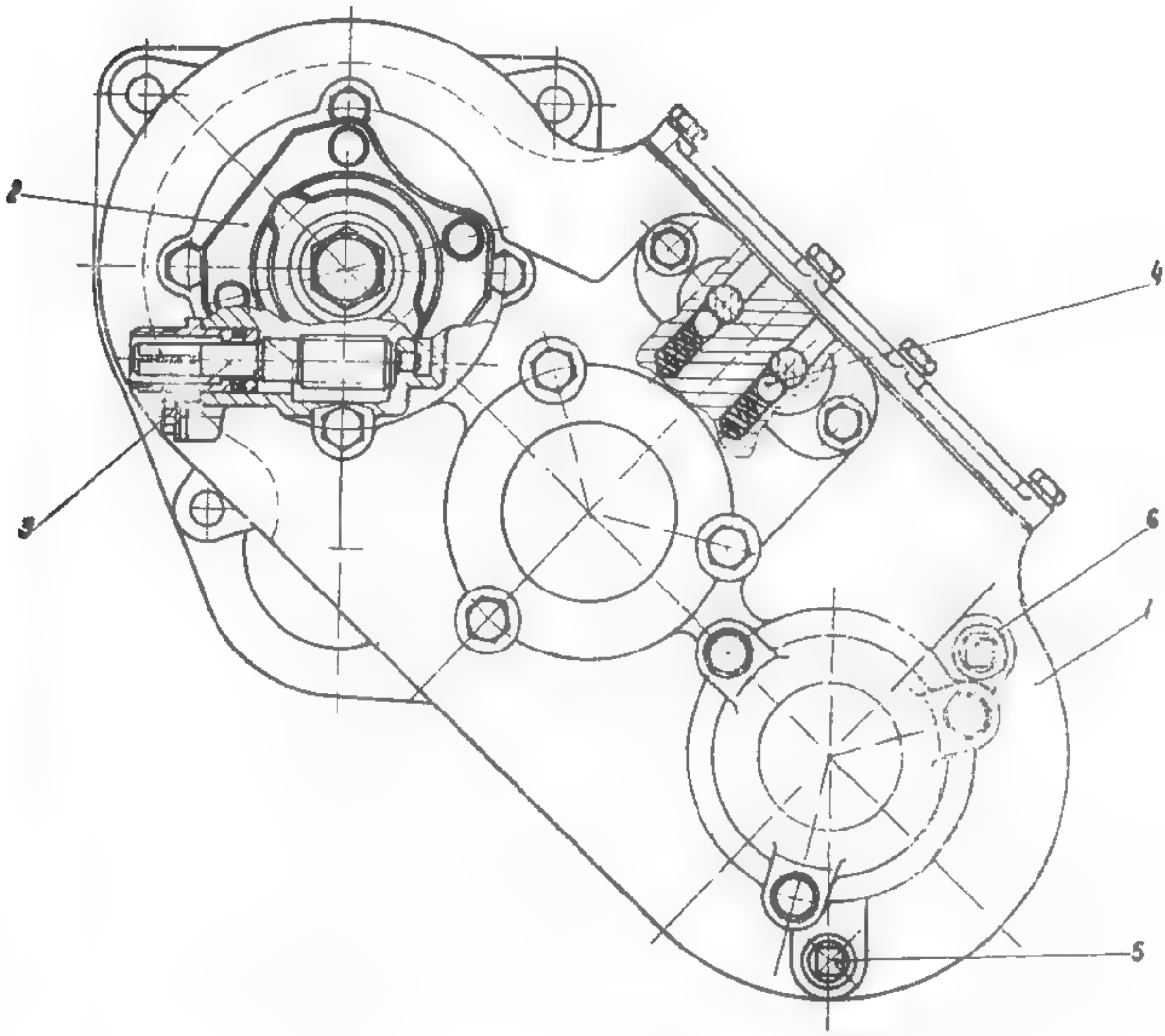


Fig. 4.106. TRANSFER BOX - FRONT VIEW
1- Transfer box housing; 2- Rear propeller connecting flange; 3- Speedometer drive pinion; 4- Control lever locking ball; 5- Drain plug; 6- Oil level plug.

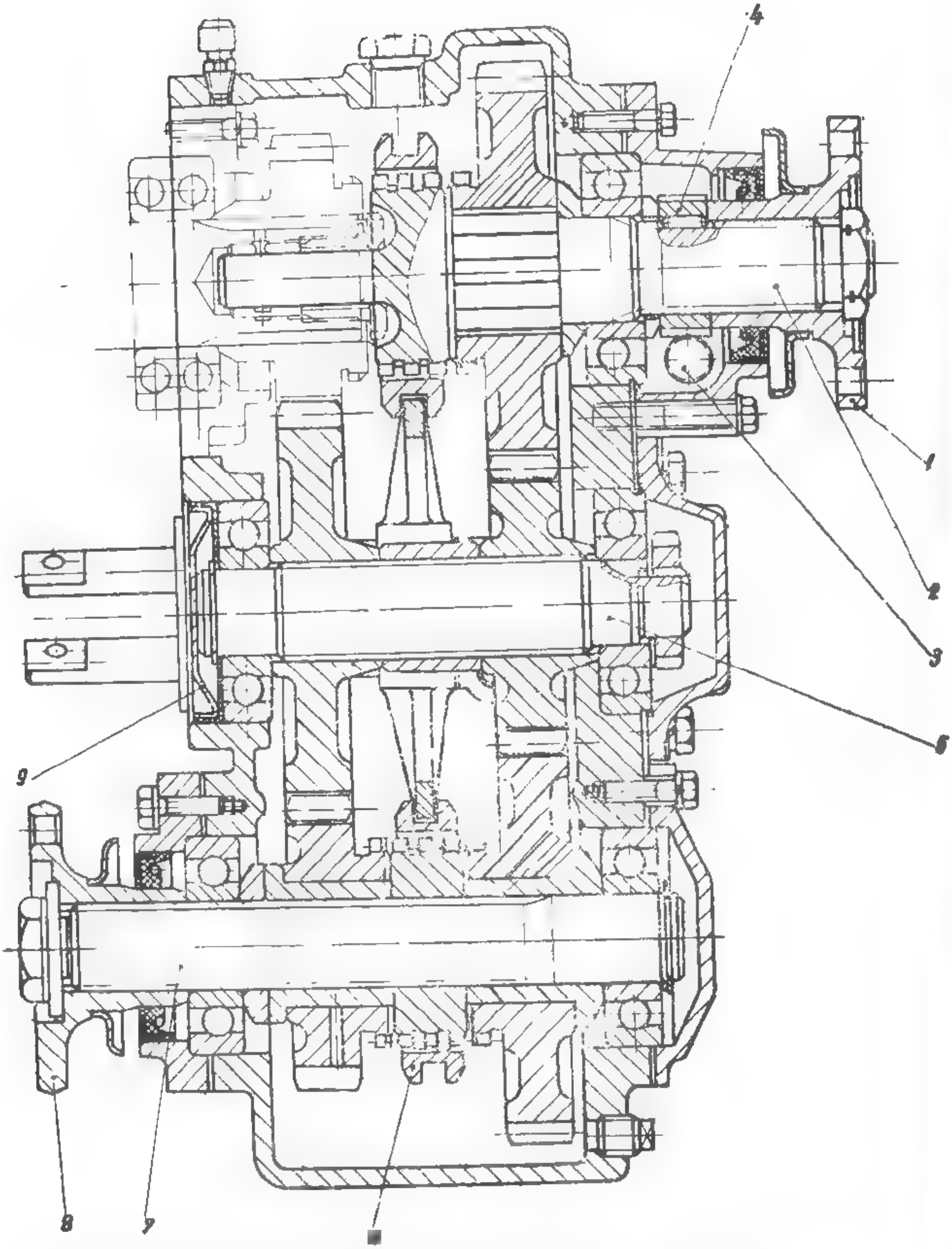


Fig. 4. 107. TRANSFER BOX GEAR - LONGITUDINAL SECTION
1- Rear propeller shaft drive flange; 2- Rear propeller shaft drive **shaft; 3**- **Speedometer drive worm** ; 4- Speedometer drive pinion; 5- **Intermediate** shaft; 6- Ring coupling pinion on the shaft; 7- Front propeller **shaft drive** shaft; 8- Front ptopeller shaft connecting flange; 9- Sealing cover.

4. 3. 3. 5. TROUBLES & REMEDYING POWER TAKE OFF. MOUNTED ON GEARBOX

(see Fig. 4. 94 - pos. 3)

On special request the ARO vehicles may be equipped with a power take-off, driven by the gearbox. It consis s of:

- Gearbox drive take-off (see Fig. 4. 97, 4. 98)
- Intermediate support (see Fig. 4. 97 or 4. 109)
- The pover take-off itself (see Fig 4. 138 and 4. 140)
- The connecting elements (cadran shafts) betwenn above units.

NOTE: The power take-off itself can be replaced by a belt pulley.

4. 3. 3. 6. OPERATIONS FOR REMEDYING GEARBOX & TRANSFER BOX ASSY (INCLUDING THEIR VARIANTS)

OP. 2. 0. 17. 01. 3 TAKING DOWN GEARBOX & TRANSFER BOX ASSY

ing gearbox & transfer box assy from vehicle should be performed after a certain travel, so that the oil gets warm.

- Remove transmission tunnel cover.
- Remove firstly filler plugs of gear & transfer boxes and then respective drain plugs, collecting the drained oil in adequate vessels.
- Take down both propeller shafts and, if existing, the power take-off cadran shaft.
- Disconnect lead of reverse speed transmitter (switch).
- Remove clutch release fork.
- Remove speedometer flexible shaft (connection on transfer box).
- Unscrew nuts fastening gearbox on clucth housing.
- Hold gearbox with a strip, in order to prevent distortion of its transmission shaft. Draw gearbox backwards, untill transmission shaft gets out from clutch disc hub.

- Remove from gearbox transmission shaft end plate the clutch throw sleeve.

On refitting gearbox & transfer box assy, perform the above stages in reverse order and tighten bolts with a torque of 2.4 - 4.0 m. daN (17.4-29 ft.lbs).

OP. 2.1.17.02.0 DISMANTLING ASSEMNLED GEARBOX

This operation can be performed, the gearbox being either mounted on vehicle or taken down form it.

In case that the trouble has been localized in gearbox shift forks or in transfer box, the remedyng can be performed without taking the whole assembly down from vehicle. Thus, for removing gearbox shift forks remove firstly the transmission tunnel cover and then the gear shift cover - the forks being fitted in it.

For taking transfer box down perform successively the following stages:

- Remove transmission tunnel cover.
- Drain oil from transfer box housing.
- Disconnect flexible speedometer shaft.
- Disconnect lead of back up light.
- Take down front propeller shaft.
- Unscrew bolts fastening transfer box on gearbox housing and disengage transfer box from gearbox main shaft.
- Remove hollow pins, using S 112 extracting mandrel.
- Remove shift lever ball cover, shift lever and the its coil spring.
- Remove gear shift lever assy, and, if necessary, also the hollow pin.

  On refitting this assembly, perform the above stages in reverse order, taking care that the lock ball coil springs enter the pockets provided in the gear shift cover.

In case that the gearbox is taken down from engine, remove hollow pins, using S 112 extracting mandrel, remove shift lever ball cover, shitf lever ball and its coil spring. After that, remove gear shift lever assy and,

if necessary, depress the the hollow pin. Then unscrew bolts, fastening transfer box, and remove the latter, disengaging it from gearbox main shaft.

OP. 2. 1. 17. 03. 0 DISMANTLING GEARBOX CONTROL

Both gearbox covers have fitted on them gear shift lever (the upper cover) and gear shift forks (the lower cover).

For dismantling gear shift lever and its knuckle perform successively the following operation stages·

- Remove shift lever knob, by drawing it with force.
- Remove shift lever boot.
- Remove hollow pin, using S 112 extracting mandrel.
- Remove ball-shaped knuckle cover and gear shift lever ball.
- Remove coil spring.
- Now, draw out shift lever and if necessary, remove also the hollow pin.

For dismantling gearbox shift forks, proceed as follows:

- Bring the forks to the middle position, as shown in Fig. 4. 99
- Remove gear shift cover, assembled with the shift lever, together with its gasket.
- Remove the lower gearbox cover, on which the shift forks are fitted.
- Remove spring and balls which lock the shift forks.
- Using S 112 extracting mandrel, depress hollow pin from 3rd - 4th shift fork shaft.
- Slacken bolt fastening the shift fork on ist shaft.
- Push the shaft laterally by slight tapping it through the gearbox cover, so that the shaft gets out from its location.
- Remove the 3rd-4th shift fork, together with its shift lug.
- Remove retainer lock pin of 3rd-4th shift fork shaft (see Fig. 4. 100).
- Slacken bolt securing the 1-st-2nd shift fork on its shaft.
- Remove the shaf' by slight tapping towads its big end, removing it together with depressing of sealing plug.
- Remove the 1-st-2nd shift fork, the adjusting washer and the retainer.

Depress hollow pin which secures reverse shift lug.

Remove reverse shift by slight tapping forwards, depressing simultaneously the sealing plug.

On refitting shift lever and shift forks perform the above stages in reverse order. Fit sealing plugs after having degreased their seats and after setting a sealing solution layer.

OP. 2.1.17.04.0 DISMANTLING REMEDYING THE GEARBOX

In order to get the best working position on dismantling and remedying the gearbox, fasten it into D 107 special device.

- Take transfer box down, using special S 113 wrench for unscrewing bolts in the area of control levers.
- Remove both assembled upper and lower gearbox covers, together with respective gasket.
- Depending on trouble location (wears, jammings, blockings, etc), dismantle in the following order: transmission (primary) shaft, main shaft and reverse shaft, together with all components which are fitted on them, and respective gaspective gasket.
- Remove transmission shaft, assembled with its bearing, by slight lateral tapping and drawing outwards. If the bearing is worn and has exccessive play, remove the snap ring, using S 114 pliers, and then the spacer ring, both shims and finaly the bearing, by depressing it on a press.
- On refitting perform the above stages in reverse order.

OP. 2.1.17.05.0 DISMANTLING PRIMARY (TRANSMISSION) SHAFT

- Unscrew bolts fastening transmission shaft end plate, making thus the adjusting flange free. Remove the latter, after having marked its face

towards the and plate and end plate position on gearbox housing. (very important for centering end plate on refitting it).

- Remove end plate, both shims and synchronizer outer housing (see Fig 4. 95)
- Remove the transmission shaft, assembled with the bearing, by slight lateral tapping and by drawing it forwards. In case the bearing is worn, has exccessive radial play, remove the snap ring, using S 114 pliers, and depress, the worn bearing on a press.
- Replace the worn bearing by a new one.
- On refitting transmission shaft, perform the above stages in reverse order

OP. 2. 1. 17. 06. 0 DISMANTLING GEARBOX MAIN SHAFT

This operation can be performed only after dismantling the transmission shaft.

If only the bearing removing is necessary, it can be performed without dismantling the transmission shaft, but with difficulty, as the main shaft remains cantilivered in transmission shaft bore, which in his turn is cantilivered in the bearing (see Fig. 4. 95).

- Unbend wing of the lock plate, which secures the nut on main shaft end.
- Unscrew special nut and remove it together with lock washer
- Draw out from the shaft transfer box driving pinion.
- Remove bearing cover plate together with annular oil seal.
- Extract bearing housing & bearing, using two M 8 bolts, which will push upon gearbox housing.
- Draw out forwards the 2nd shift pinion and check it. If it will be found worn out, replace it by a new one.
- Remove from the other shaft end the ring securing halfrings.
- Remove both halfrings and then the shift pinion.
- Through the gearbox upper side remove the main shaft with all components fitted on it.

- Now, remove trom the main shaft synchromesh mechanism for 3rd and 4th shift and 3rd shift pinion, removing after that the snap ring.
- Check the main shaft for wear or seizing traxces, which should be removed using a fine grit stone -
- Remove lock pin, then rotate and remove the grooved retaining ring.
- Remove from the main shaft the 2-nd shift pinion, together with assemble synchronizer housing.
- Check all components of assembly for wears or faults and if necessary replace them with original components.

On refitting the main shaft, perform the above stages in reverse order.

OP. 2.1.17.07.0 DISMANTLING THE LAYSHAFT (INTERMEDIATE SHAFT)

This operation can be performed only after removing transmission and main shafts.

- Remove snap ring towards the transfer box.
- Shitf the layshaft longitudinally by slight tapping, untill the seal and cover plate is pressed out from opposite housing wall.
- Now shift the layshaft again, but in reverse sense, untill its bearing gets out from the gearbox housing wall (where was the snap ring on shaft). Shitf the shaft up to refuse.

  Extract the bearing which is remained in the gearbox housing front wall, by means of D 108 extracting device.
- Remove snap ring from the layshaft front end.
- Remove successively from the constant mesh gear for 4th shift, Woodruff key, spacer ring, constant mesh gear for 3rd shift and its Woodruff key.
- Extract from the layshaft the rear bearing by means of [illegible] extracting device.

- Check layshaft for its gear toothing wear and their coaxiality.

In order to ensure the minumum clearance of 0.130 mm, between the teeth flanks, for pinions Z_1 and Z_3, respectively of 0.105 mm for pinion Z_2, the pinion toothing radial play should not exceed 0.05 mm, for Z_1 and Z_3 pinions, and 0.07 for Z_2 pinion and the dimension over each pinion should have the values indicated above in the § 4.3.3.2 (Troubles & remedyings of the gearbox & transfer box assy) - : GEAR BOX LAYSHAFT. (see page).

OP. 2.1.17.08.0 DISMANTLING REVERSE SPEED PINION SHAFT

This operation can be performed only after dismantling all other shafts (in order to be able to remove and then to refit the reverse speed pinion).

- Remove the lock plate from the rear end of reverse speed pinion shaft
- By means of 110 extracting device and a M 8 screw, fitted in the shaft threaded hole (at its rear end), extract the shaft which is pressed in the gearbox housing wall.
- Remove excentric stud screw and reverse shift lever.
- Remove reverse shitf pinion.

On refitting the shaft, performe the stages in reverse order.

OP. 2.1.18.03.0. UNMOUNTING OF THE DISTRIBUTION BOX CONTROL

Unmount the gear box bonnet.

Unmount the control support by unscrewing their fixing screws on the distribution box crankcase.

Then pull out the locating pin of the lever on the support.

Unmount the superior cap and let the way free to the fixing screws of the forks on the axles.

- Remove successively both control shafts, by slight tapping towards the outer ends. Remove then both forks, after having previously marked their relative position in transfer box housing. TAKE CARE that the balls, located under the control shafts, do not fall into transfer box housing.
- Remove the plate (5) and the sealing rings.

NOTE: The transfer box control is so assembled the it can be coupled with the reduction gear only after coupling the front wheel drive. This condition is realized by the retainer (6), which allows the shifting of reduction gear coupling fork (7) for coupling reduction gear, only simultaneously with the fork controlling the front axle drive. This system allows also the front axle coupling without introducing the reduction gear drive

On refitting transfer box control take care that the both forks should be in their middle position.

OP. 2.1.18.04.0 DISMANTLING TRANSFER BOX

On dismantling the transfer box fasten it in D 111 device, in order to make easier this operation. Setting the transfer box having its drain plug in its lower position, unscrew the plug and let oil drain collecting it in a vessel.

OP. 2.1.18.05.0 DISMANTLING REAR AXLE DRIVE SHAFT

(see Fig. 4.107)

- Take down coonecting flange (1), after removing the snap ring, securing nut and castellated washer.
- Check connecting flange for wear in the area of annular oil seal. If the wear is visible, replace the flange with a new one
- Remove speedometer drive cove , together with speedometer drive gear assy and remove also its gasket.

In case that annular oil ring lip is damaged, replace it, pressing the new ring up to the cover surface.

- Remove the lock plate, securing speedometer shaft sleeve nut.
- Remove speedometer shaft sleeve nut, together with the speedometer drive shaft.
- Remove from rear axle drive shaft the speedometer drive pinion (4), and after that the drive pin.
- Remove spacer ring, between pinion and bearing.
- Depress rear axle drive shaft out bearing, by slight tapping, removing after that the spacer ring and the low speed driven gear.
- Check the shaft for coaxiality and wear on the area with bearing nedles. (see Fig. 4 108).

OP. 2.1.18.06.0 DISMANTLING THE LAYSHAFT

- Remove rear layshaft cover, togerher with ist gasket.
- Undo lock washer from the nut and remove both components.
- Shift the layshaft forwards by slight tapping, untill the sealing cap (9) is pushed out from its bore.
- Remove spacer and snap rings from the layshaft front end.
- Now, shift the layshaft backwards by slight tapping, removing it together with bearing from transfer box housing.
- Check bearing for wear and, if necessary, replace it by a new one.
- Remove from the housing both layshaft low and high speed gears, together with the spacer sleeve.

OP. 2.1.18.07.0 DISMANTLING FORNT AXLE DRIVE SHAFT

- Take down connecting flange (8) - see Fig. 4.107 - proceeding similarly as described in Op. 2.1.18.05.0.
- Remove bearing cover together with annular seal ring. If the latter is damaged, replace it by a new one.
- Remove also rear bearing cover.

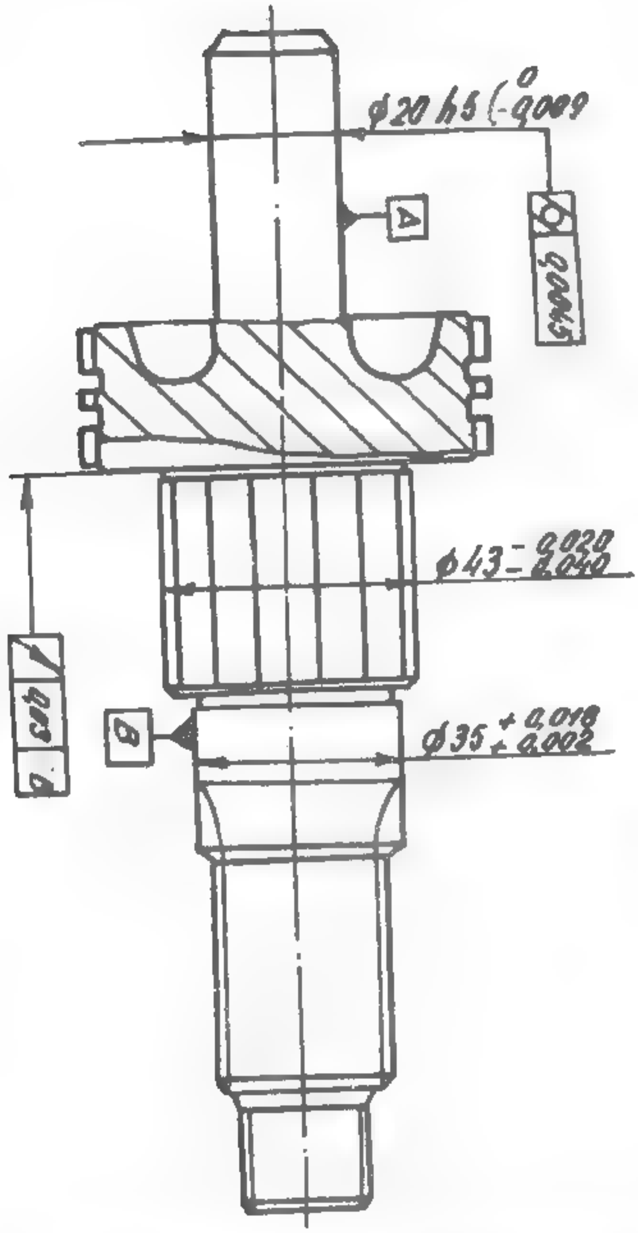


Fig. 4.108. TRANSFER BOX REAR PROPELLER SHAFT DRIVE SHAFT.

- Extract front axle drive shaft by means of D 113 extractor.
- Remove from transfer box housing both low and high speed driven gears, Oupling sleeve and splined hub, after having previously marked their mutual positions.
- Check both gear sings for wear and if necessary, replace them.

Depress bearings out from the housing by means of D 114 extractor.

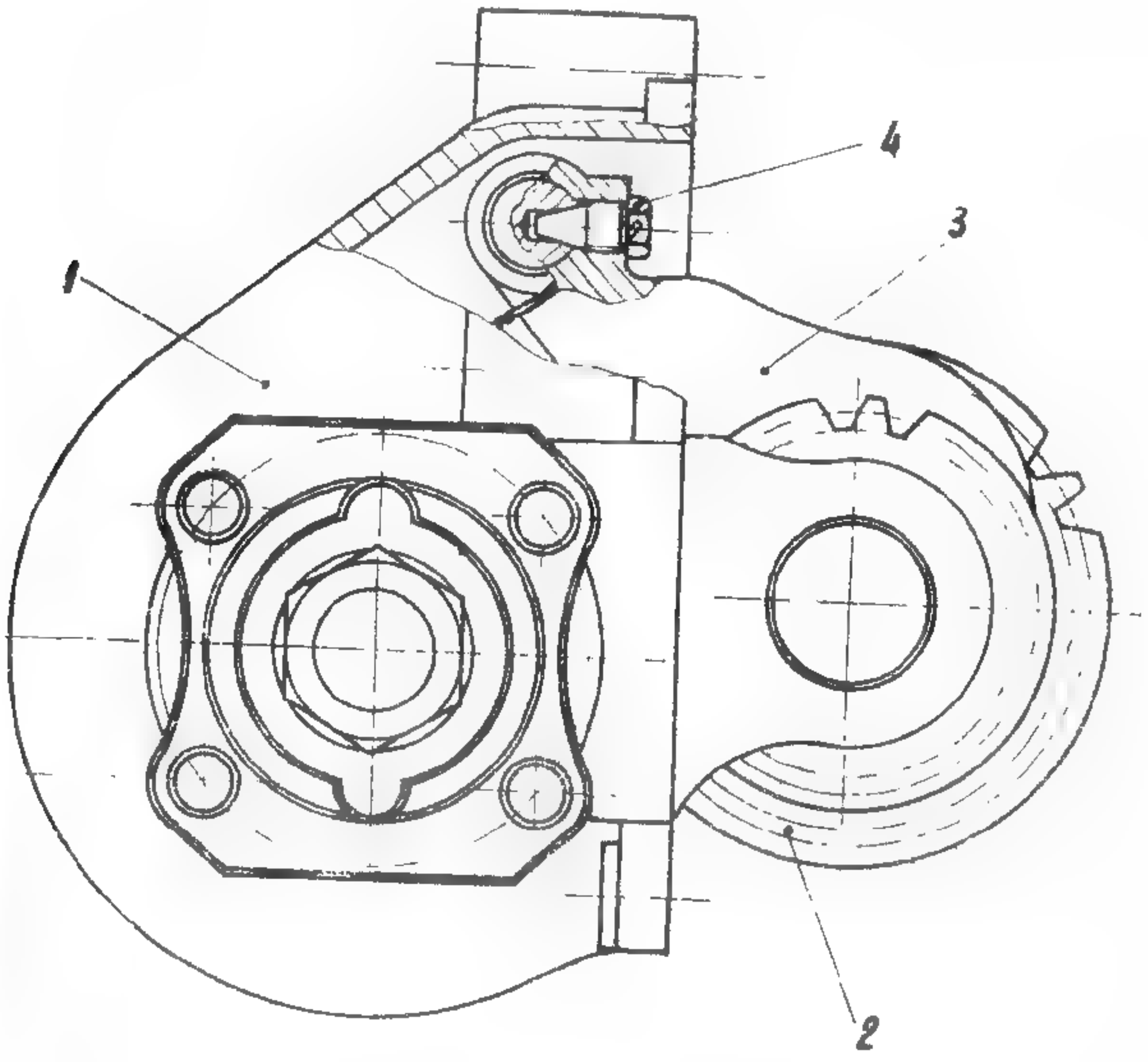


Fig. 4.109. GEARBOX POWER TAKE-OFF (see also Fig. 4.97)

OP. 2.1.18.08.0 REFITTING TRANSFER BOX

On refitting transfer box, perform the above operations in reverse order. Tighten the nuts securing both connecting flanges with a torque of 15 - 20 m. daN (108 - 144 ft. lbs.).

REMARK: In case the stud bolts have been unscrewed, refitt them on them housing using a sealing and blocking solution (such as OMNIFIT, LOCKTITE, etc).

(see also Fig. 4.97).

OP. 2. 1. 18. 09. 0 DISMANTLING REMEDYNG POWER TAKE-OF

On special require the ARO vehicles can be delivered provided with power-take off, which consists of:

- The gearbox power-take off
- Double universal propeller shaft
- Propeller shaft intermediate bracket
- The power take-off itsself, located on chassis frame back, with possibility to be replaced by the belt pulley (see Fig. 4. 97, 4. 98 and 4. 109)

To get an easier access to power take-off, fitted on the gearbox, remove firstly transmission tunnel cover and disconnect propeller shaft from prower take-off flange (5) - Fig- 4-98.

- Now, perform the following stages in the given order :
- Drain oil from gearbox.
- Undo split pin securing the power take-off control lever and remove the latter.
- Unscrew bolts fastening power-take off on gearbox.
- Remove power take-off assy and fasten it on D 115 device.
- Unscrew and remove bolt (4) - Fig. 4. 109 - securing the shift fork on the control shaft.
- Remove control shaft by slight tapping.
- Remove the shift fork, lock ball and its coil spring.
- Remove screw (3) - Fig. 4. 98 - securing slide gear shaft (2).
- Remove successively snap ring and lock washer securing the nut fastening connecting flange on power take off shaft.
- Lock the flange postition, using the D 116 device.
- Unscrew nut fastening the flange.
- Remove bearing cover.
- Shift the shaft towards the bearing cover.
- Remove power take-off drive pinion (4) - Fig. 4. 98.
- Remove snap ring and the bearing from the shaft , by means of D 117 extractor.

- Remove slide gear shaft (2), by tapping it slightly towards the location hole of locking screw (3).
- Remove sliding gear
- Remove annular oil seal from the housing.
- Remove snap ring from the housing bearing bore (Ø 62 mm) and then draw out the bearing, using D 117 extractor.
- Check all components for wear and replace the faulty components by new original ones.

On refitting power take off perform the above stages in reverse order.

4.3.4. TROUBLES & REMEDYNGS OF CARDANIC TRANSMISSION

4.3.4.1. DISCRIPTION OF LONGITUDINAL TRANSVERSAL CARDANIC SHAFTS

The ARO vehicles are equipped with open type, telescopie cardanic shafts, provedied on both ends with universal spider joints, which can rotate on needle bearings. They differ by their length and by longitudinal shift stroke. Depending on their position on the vehicle, there are two cardanic shaft types:

- Longitudinal cardanic (propeller) shafts, which convey engine torque to rear and front differentials.
- Transversal (cross) cardanic shafts, which convey the driving torque to both front wheels.

The splined head, pipe and yoke are welded and cannot be taken to pieces.

All propeller shafts are dynamically balances up to maximal allowed imbalance of 30 gr.cm. The maximal travel of the sliding yoke is of 25 mm for cross and front longitudinal propeller shaft and of 7 mm for longitudinal rear propeller shaft.

4.3.4.2. TROUBLES REMEDYINGS OF PROPELLER SHAFTS

The troubles and wears which can occur during vehicle operation, usually appear in spider joints and sliding yoke.

The main troubles that can occur are:

- The wear of yoke and splined head slots.
- The wear od spider journals.
- Unbalance exceeding the allowed limit.

The main cause which leads to such premature wears is the lack of lubricant in the shaft universal joints and in the sliding yoke hollow.

In case that advanced wears will be found in the slots, replace either sliding yoke or propeller shaft welded assy.

The angular play between the slots of propeller shaft and yoke should be within the limite 0.08 - 0,03 mm, for evolvent shaped slots, and 0.08 - 0.15 mm, for rectangular shaped slots. This angular play should be measured on pitch circle diameter of evolvent shaped slots.

In case that wears will be found in universal joints, replace the spiders and, if necessary, the needle bearings.

The axial play (along the spider journal axes), between the spider journal thrust faces and inner faces of needle bearings should be within the limits of 0.040 and 0.366 mm.

In case that propeller shafts will be remedied by replacing different components, they should be dynamically balanced with a maximal residual imbalance of 30 gr. cm.

During the dismantling of a vehicle do not interchange components between them.

Defore dismantling propeller shafts check if the arrows, marked on propeller shaft slotted end and on sliding yoke, are on the same line. If not, make this marking before dismantling. On refitting take care that marking arrows should come on the same line.

4.3.4.3. OPERATIONS FOR REMEDYING PROPELLER SHAFTS

Op. 2.0.22.04.0 TAKING PROPELLER SHAFT DOWN FROM VEHICLE

Performe this operation after having lifted the vehicle on an inspection ramp.

- Undo lock plates, securing nuts on propeller shaft flange and unscrew respective nuts.
- Manually slide the yoke towards propeller shaft centre and remove bolts from the flange.

For longitudinal propeller shaft this operation is performed on both shaft ends. (see Fig. 4.110).

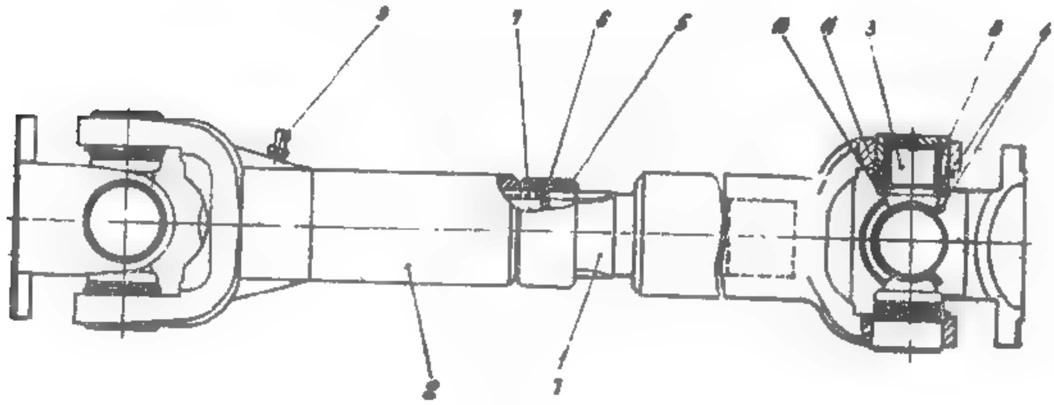


Fig. 4.110. LONGITUDINAL PROPELLER SHAFT
1- Propeller shaft; 2- Sliding yoke; 3- Spider;
4- Snap ring; 5- Felt gasket; 6- Fastening ring;
5- Cover; 8- Needle bearing; 9- Grease nipple;
10- 11- Sealing gasket.

For cross propeller shaft the operation is performed only on one shaft end. On the other end proceed as follows;

- Remove hub cap from respective front wheel.

- Remove axle cap, protecting the nut securing wheel connecting flange on axle shaft, wich in his turn is connected with cross propeller shaft.
- Remove split pin and unscrew the nut.
- Remove propeller shaft by blowing the axle shaft (steering knucle 4) - see Fig. 4. 111,-and depressing it from the bearing. Use for this operation an aluminium or plastic hammer.

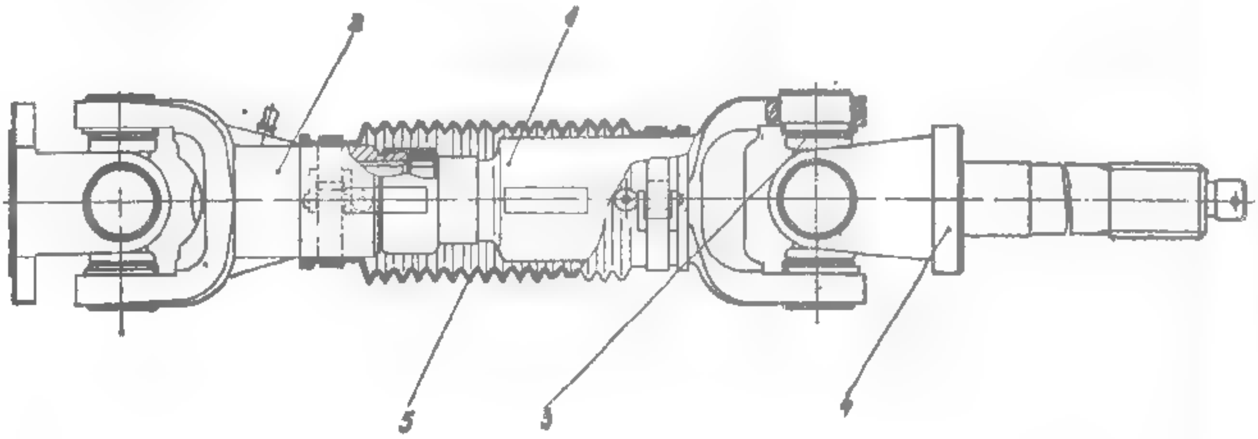


Fig. 4. 11. CROSS PROPELLER SHAFT
1- Propeller shaft; 2- Slide fork; 3- Spider; 4- Steering knuckle; 5- Sealing boot.

OP. 4. 1. 22. 05. 0 REMOVING SLIDING YOKE FROM PROPELLER SHAFT

Before dismanling this assembly check if on the sliding yoke as well as on propeller shaft splined head are marked the arrows and if these arrows are aligned. If the arrows are not visible, mark them again clearly, before dismantling the assembly.

- Remove sliding yoke, drawing it slightly out. Remove grease nipple from off the yoke.
- Check both components if their slots have marked wears or seizing traces. The seizing traces can be removed by trueing up slots with a fine grit stone. The propeller shafts having worn out slots should be replaced.

- On refitting, take care that both arrows should be aligned on the same axis. If one of both components was replaced check deviation of universal joints mutual position, which should not exceed $1^{o}30'$.
- On refitting both components, introduce into sliding yoke hollow about 100 gr. grease, through the grease nipple or directly into hollow, by means of a blade.

After assimbling the angular play in the slots should be within prescribed limits. (see § 4. 3. 2.)

OP. 4. 1. 22. 06. 0 DISMANTLING UNIVERSAL JOINT

- Remove snap rings (4) - see Fig. 4. 110 - from spider journals, using special S 119 pliers or a hammer and drift.
- Extract needle bearings (7) from bores in yoke and flange as follows : yoke or flange being fixed in a bench vice, press with S 120 extracting device on a needle bearing untill opposite needle bearing is free of bore. Then press on spider to make free the other bearing.
- Repeat operation with the other two needle bearings (see Fig. 4. 112).

If a S 120 extractor is not available, the neadie bearings can be thrust out with hammer and drift.

- Remove grease nipples (9) from off sliding yoke and spiders.
- After washing and drying the dismantled components, check spider journals for right dimensions and traces of wear or seizing.

Minimal allowed diameter of spider journals should be 16. 3 - 0. 18 mm

Spiders with a more pronounced wear should be replaced with new original components.

- Check condition af spider journal gaskets.
- Check operation of grease nipples.
- Check needle hearings by fitting them on a new spider having its journal diameters of 16. 3 - 0,012 mm. After fitting the checked bearing on spider journal, the radial play between both components shioud not be perceptible. The non-corresponding bearing should be replaced by new components.

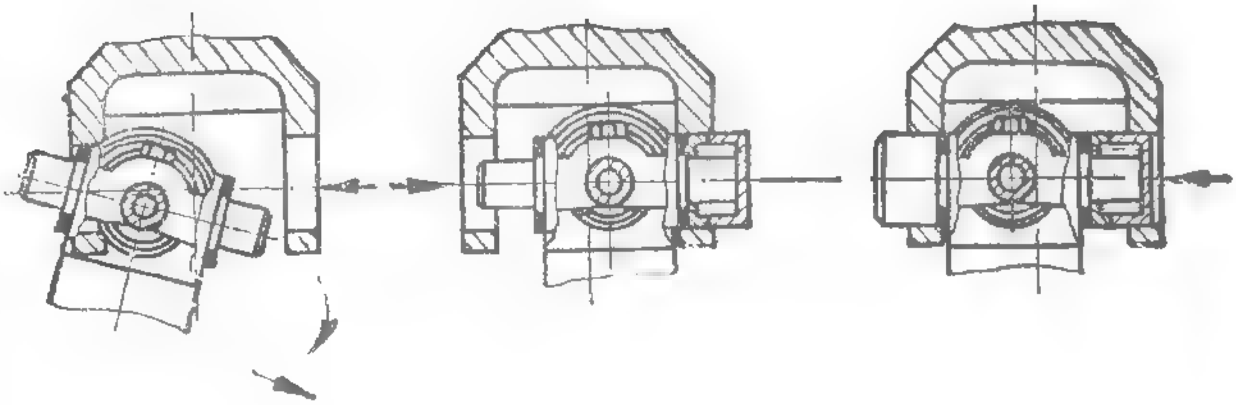


Fig. 4.112. DISMANTLING NEEDLE BEARINGS SPIDERS

OP. 4.1.22.07.0 REFITTING THE PROPELLER SHAFT

On refitting, use only corresponding components which have not wears beyond the allowed limits. Before refitting, all components should be washed in kerosene, petrol or white spirit and then dried by blasting them with compressed air.

Fit on the spider grease nipple and the gaskets.

- Assembly spider with sliding yoke assy, respectively with propeller shaft assy, by slight pressing of bearings, performing this operation on press or manually, using an aluminium hammer.
- Secure needle bearings with snap rings (4) using an 0.250 kg hammer. On assembling take care that grease nipple should point inwards.
- Assembly propeller shaft with the sliding yoke. On this operation take care that both arrows an yoke nd shaft should be aligned.

  On assembling both components should glide, slightly (only by hand pressure) together, without any perceptible angular play.

  Fit grease nipple on sliding yoke.

  Grease sliding yoke and spiders with (M L1CaPb3 grease (or equivalent one), untill grease traces appear around sealing gaskets of needle bearings, respectively around the sliding yoke sloted end.

- Whenever a part is replaced by a new one, it is necessary to balance dinamically the whole assembly, by welding balance plates either on sliding yoke or on prepeller shaft pipe, untill the residual imbalance will be within prescribed limits (see 4.3.2).
- Fit on flanges bolts, washers, lockplates and nuts.

4.3.5. TROUBLES & REMEDYINGS OF THE FRONT DIFFERENTIAL

4.3.5.1. DESCRIPTION OF THE FRONT DIFFERENTIAL

The front differential driving gear consists of an aluminium housing, bevel drive gear with curved toothing driving the differential case, which contains two differential pinions and two planet pinions (side gears), both with bevel straight toothing.

All gears have concurrent axes at 90°.

The maximum power, conveyed by differential driving gear is 50 kW (68 H.P.) and the rear axle driving pinion has its max. speed of 4,200 r.p.m.

The maximal conveyed torque is of 360 m.daN (2,600 ft.lbs.).

The transmission ratio between the driving pinion and bevel crown wheel is 4.714, in case the car is fitted with 6.50- 16" wheels, or 5.15 in case it is fitted with 7.50 - 16" wheels, while by vehicles equipped with Diesel engine this ratio is only 3.72.

The recommended lubricant for differential gear is T90EP.

The optimum lubricant quantity is 1.2 litres.

During a correct operation, the outer surface temperature in the bearing area should net exceed 65°C (210°F), when the ambiant temperature is 20°C (68°F).

Notice that correct gear meshing clearances and correct adjusted drive pinion bearing tightening should secure: - Drive pinion max. rotation torque, not engaged with the crown wheel (i.e. before fitting differential case assy) a value of 0.016 - 0.020 m.daN (0.115 - 0.145 ft.lbs.).

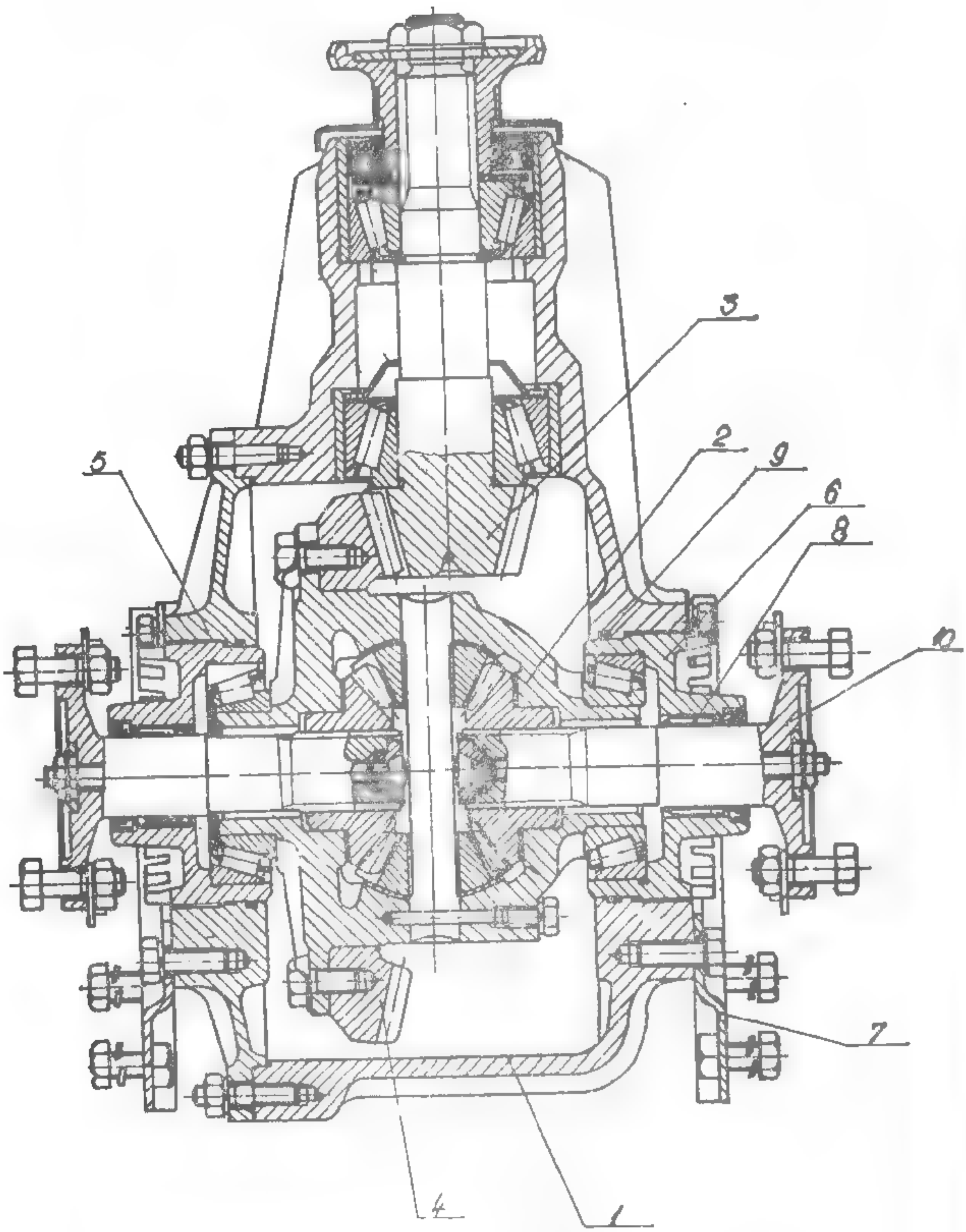


Fig. 4.113. FRONT DIFFERENTIAL ASSY

1- Differential housing; 2- Differential case; 3- Drive pinion; 4- Crown wheel; 5- Differential big cover; 6- Taper bearing slotted adjusting nut; 7- Mounting bracket; 8- Needle bearing; 9- Sealing ring; 10- Dif. half - axles.

- Drive pinion maximal rotation torque, when differential drive gear is completely assembled, withn the limits 0.025 - 0.035 m-daN (0.18 - 0.25 ftlbs.)

The differential drive main components are the following:

- Differential housing (1)
- Differential big cover (5).
- Differential small cover (6).
- Differential drive pinion (3).
- Axle shafts (10).
- Differential crown wheel (4).
- Differential case (planet wheel carrier) (2).
- Difrerential mounting brackets (7).

4.3.5.2. TROUBLES REMEDYINGS OF THE FRONT DIFFERENTIAL

TABLE XXII

T r o u b l e	Its cause	Necessary remedying
Continuous noise or whysle during vehicle running	Unadjusted bevel gear (wrong backlash between driving pinion and crown wheel)	Bevel gear should be adjusted so that the contact spot on tooth flanks will result correctly.
Pronounced noise with intermitance, which occurs during vehicle running	Broken tooth of diff. bevel gear	Replace bevel gear, i.e. driving pinion and crown wheel
Characteristical noise which appears spontaneously during the vehicle running.	Diff. case collar broken	Replace differential case
Oil leakages around diff. covers	Covers sealing O-rings broken	Replace damaged O-rings.

Differential blocking	Advanced wear (break) or diff. case collar broken	Dismantle differential and replace damaged parts.
Leakages around annular oil sealings	Oil seal rings damaging or ageing	Replace faulty annular seal rings
Excesive heatings	Roller bearings too tight	Adjust bearing play (backlash)

REMARK: - Do not use on refitting the components which are worn beyond prescribed limits.

- Do not fit dismated bevel gears. The driving pinion and the crewn wheel should have marked on the same number.
- On refitting, blast all components with compressed air or wipe them thereugly from impurities.

4.3.5.3. OPERATONS FOR REMEDYNG FRONT DIFFERENTIAL

OP. 2.0.23.06.0 TAKING FRONT DIFFERENTIAL DOWN FROM VEHICLE

Perform remedying operation only when differential is warm, after a certain vehicle travel. A quarter of an heur let oil collect at the bottom differential housing. Then unscrew the drain plug and drain oil completely.

- Screw back the drain plug.
- Getting access from underside of vehicle, remove differential bleeding hose.
- Take longitudinal and cross propeller shafts from the front differential.
- Unscrew bolts fastening differential mounting brackets on chassis front cross member and remove differential.

The troubles which will be found are caused by wear of some differential components, which should be replaced by new, original ones.

OP. 4.1.23.06.0 DISMANTLING F.A.D. OF DIFFERENTIAL

- Remove snap rings securing nuts of axle shafts and then the lock washers.

- Unscrew nuts securing axle shaft fixing bolts.

- Remove both axle shafts, sliding them slightly outwards.

- On dismantling differential, unscrew slotted adjusting sleeve (6), remove it from big cover (5), using for this S 401 special wrench.

- If annulator oil seal of the cover will be found faulty, depress it out by means of D 124 adjustable extracting device, in order to replace it by a new one.

- Unscrew bolts fastening the big cover and remove it, together with its O-ring seal.

- Screw in the S 125 handle into the axle shaft fixing bolt and remove it attentively the whole assembly, i.e. the differential case assembled with the crown wheel.

- Remove from differential case the two bolts fixing the two axle shafts.

- Unscrew bolts fastening the small cover and remove it, together with its O-ring seal.

- Remove from differential housing the bearing outer race of differential gear case, by means of D 125 extractor.

- Fasten differential housing in the D 126 mounting device.

- Lock position of propeller shaft flange by means of D 116 locking device.

- Remove snap ring and fixing washer from driving pinion shaft end.

- Unscrew respective nut by means of a socket wrench.

- Remove propeller shaft flange by slight sliding outwards.

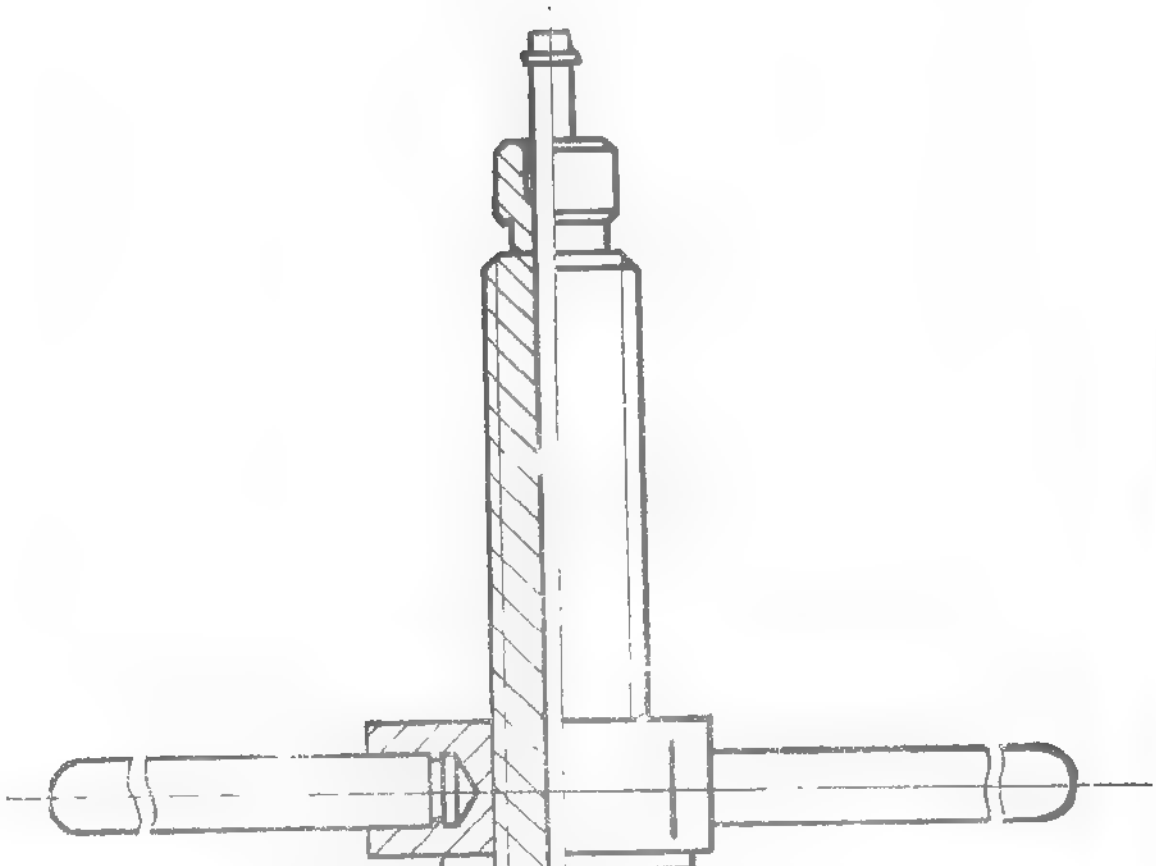
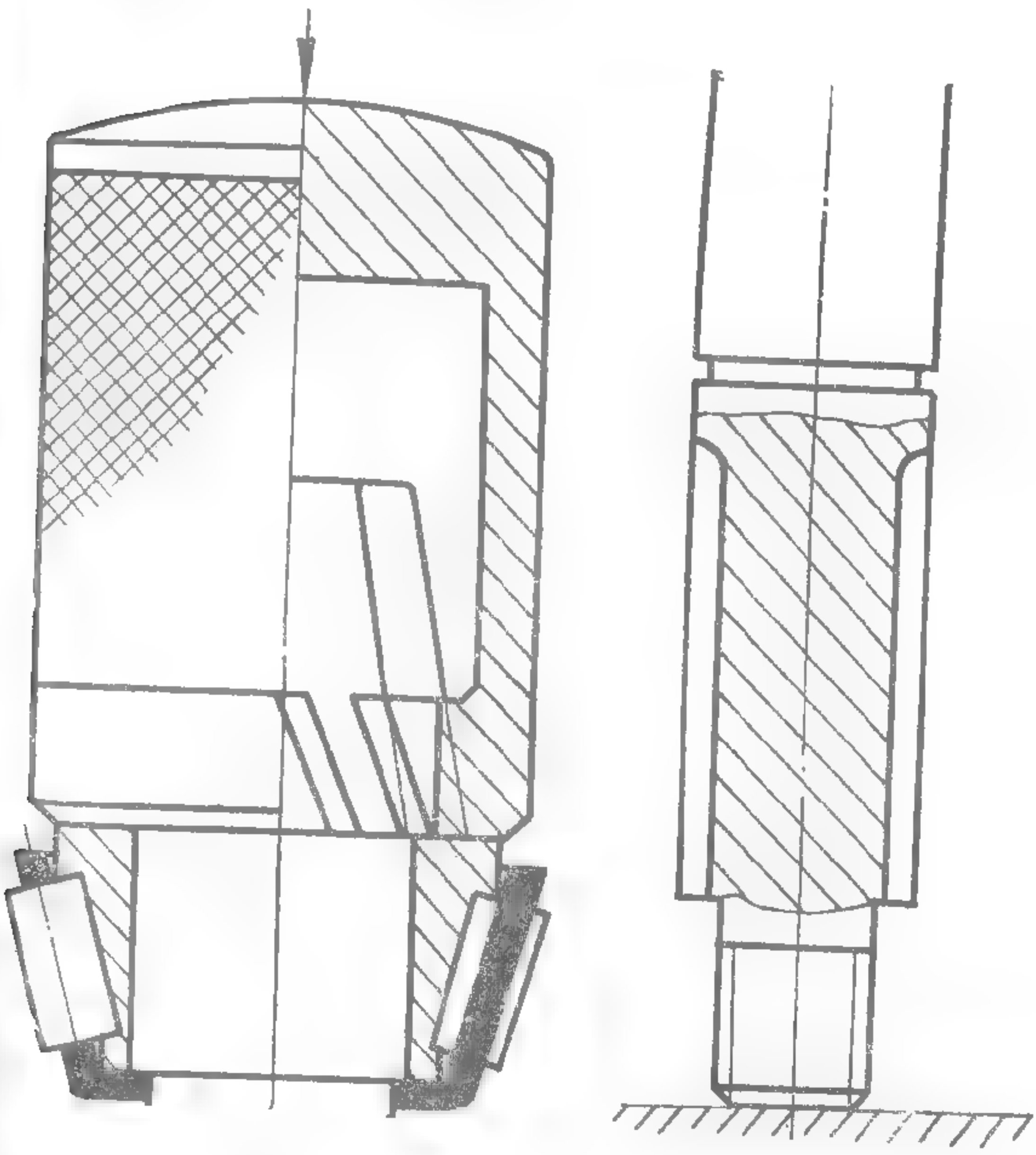


Fig. 4.114. EXTRACTING DRIVE PINION REAR BEARING OUTER RACE

- Remove driving pinion by slight tapping inwards the housing, retaining it by hand, in order to not let it fall or damange the housing.
- Depress the O-ring seal from behind the flange, using D 124 extracting device.
- Remove oil slinger, located above the bearing.
- Depress inner bearing race from off the driving pinion shaft, using the S 133 extracting bushing (see Fig. 4. 115)



a b

Fig. 4. 115. EXTRACTING DRIVE PINION REAR BEARING INNER RACE

- Depress outer race of driving pinion rear bearing (see Fig. 4.114).
- Depress from off differential gear case, by means of S 126 extracting device, the outer race of driving pinion inner bearing, and simultaneously the oil slinger and adjusting shim.
- Depress from off the big cover, using D 125 device, the outer race of differential gear case.
- Depress from off differential housing the needle bearings, using the S 127 mandrel.

OP. 4.1.23.05.0 DISMANTLING DIFFERENTIAL GEAR CASE

- Set differential gear case assy in the D 127 mounting device ans remove successively, using D 124 extracting device, the inner races of differential gear case (see Fig. 4.117).
- Undo tab washers locking the bolts fastening crown wheel on differential gear case and remove the bolts.
- Remove crown wheel from the case by slightly tapping around.

ATTENTION ! The crown wheel and driving pinion are mated mutually in the manufacturing plant and should be always mounted together in the same differential gear.

- Fasten differential gear case in D 128 mounting device.
- Unscrew bolts securing differential pinion spindles (see Fig. 4.116).
- Remove differential pinion spindles by tapping.
- Locking one of the differential side gears (planetar pinion), turn the opposite one bringing the differential pinions, one by one, facing the gear case opening and remove them through the opening, together with their thrust washers (7). On refitting differential gear case assy perform the above stages in reverse order, using the same special devices.
- Tighten bolts securing the crown wheel with a troqus of 6 - 7 m. daN (43.5 - - 50.5 ft. lbs).

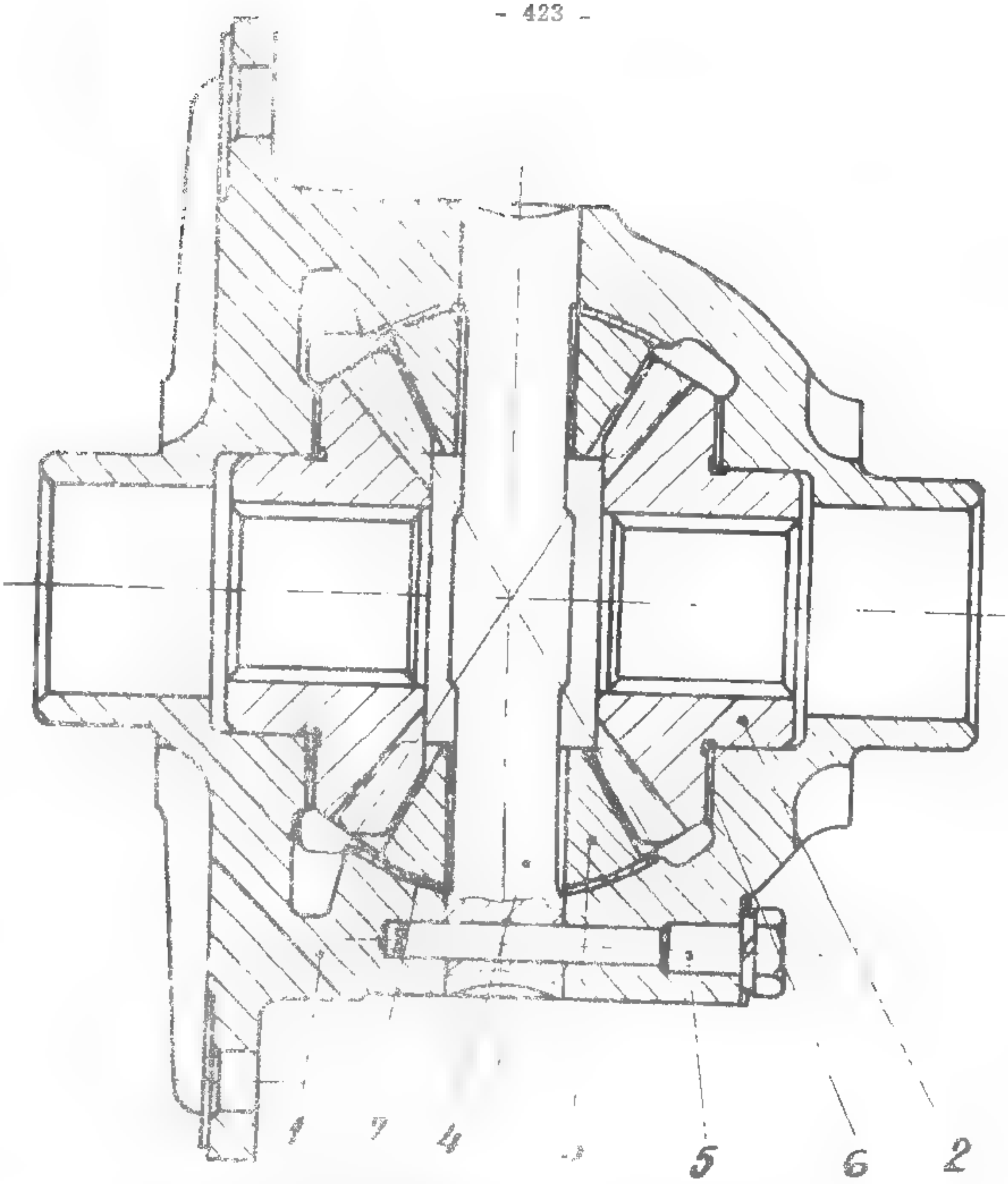


Fig. 4 11 . DIFFERENTIAL CASE ASSY
1- Differential case; 2- Side gear; 3- Differential gear; 4- Differential gear shaft; 5- Shaft locking; 6- Differential pinion washer; 7- Side gear washer.

When [illegible] condition of differential gear, the clearance between differential side gears and their thrust washers should not exceed 0,2 mm (see Fig. [illegible]).

The meshing of differential side and bevel pinions should be free of jamming or resistance on rotating (this condition is to be checked up by locking a side pinion and rotating the other one by hand. This rotating should occur easily).

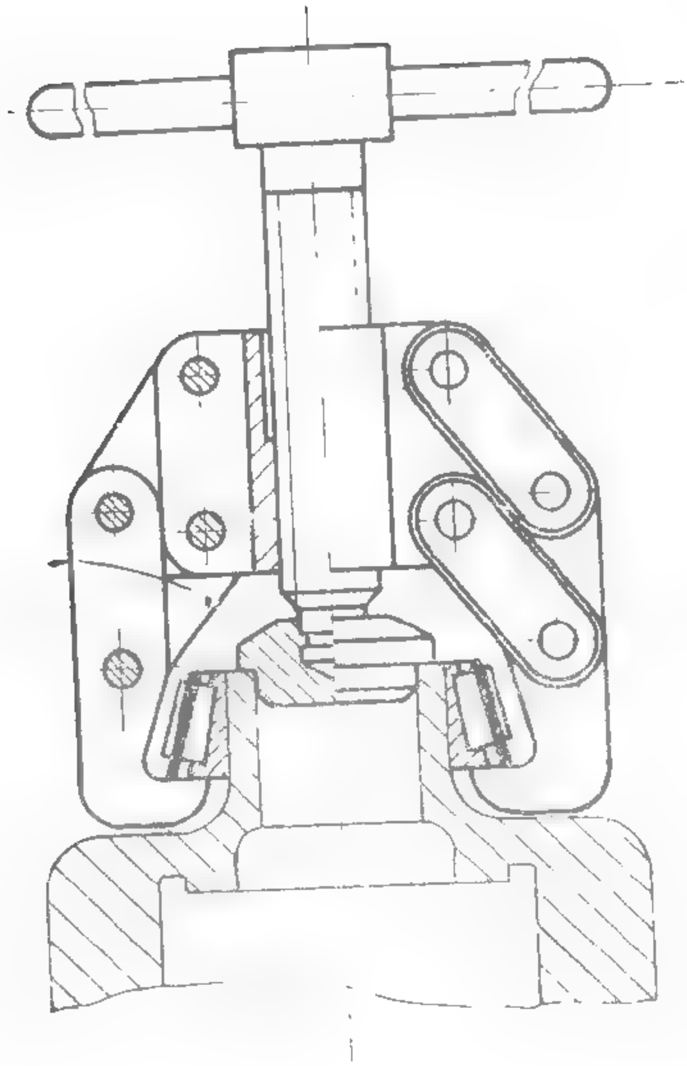


Fig. 4.117. EXTRACTING DIFFERENTIAL CASE BEARING INNER RACE

OP. 4.1.23.06.0 REFITTING & ADJUSTING THE DRIVING PINION

- Measure the differential housing, namely the dimension "B", by means of V 104 measuring device and mark the found deviation (the measuring instrument should be set to "O", using the standard gauge on its maximum position - see Fig. 4.113).

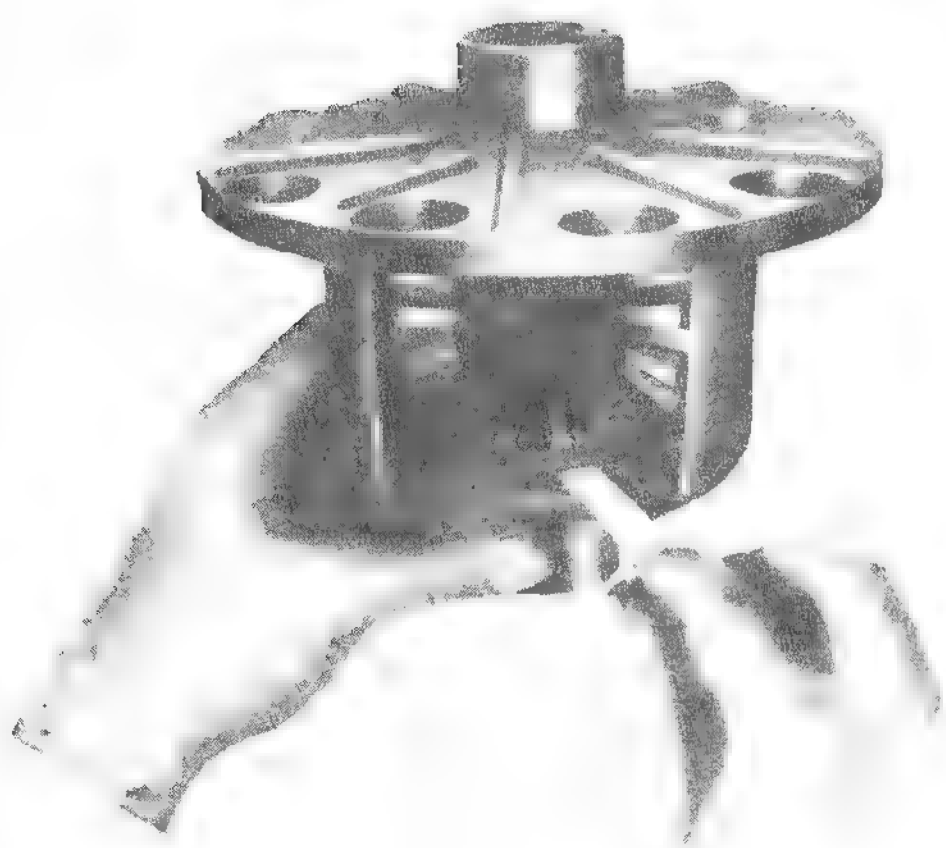


Fig. 4.118. CHECKING DIFFERENTIAL SIDE GEAR AXIAL PLAY

- Under a pressure of 160 daN (352 lbs.) the width of driving pinion inner bearing (symbol 31.308) and mark the found deviation from the rated size. The found out deviations should be rounded off from 50 to 50 microns. The deviation measurement should be done using V 105 measuring instrument.

The thickness of adjusting shim to be introduced between the inner bearing and its seat in differential housing is to be established depending on deviations that have been measured on hausing size "B", the bearing width and oil slinger thinger thickness, according to Table XXIII.

TABLE XXIII

THICKNESS OF DRIVING PINION POSITION ADJUSTING SHIMS
(Shim thickness indicated in mm.)

Bearing width deviations (microns)	Deviations of differential housing "B" dimension (microns)					
	0	+ 50	+ 100	+ 150	+ 200	+ 250
- 200	1.850	1.900	1.950	2.000	2.050	-
- 150	1.800	1.850	1.900	1.950	2.000	2.050
- 100	1.750	1.800	1.850	1.900	1.950	2.000
- 50	1.700	1.750	1.800	1.850	1.900	1.950
- 0	1.650	1.700	1.750	1.800	1.850	1.900
+ 50	1.600	1.650	1.700	1.750	1.800	1.850
+ 100	1.550	1.600	1.650	1.700	1.750	1.800
+ 150	1.500	1.550	1.600	1.650	1.700	1.750
+ 200	1.450	1.500	1.550	1.600	1.650	1.700

REMARK - The measured deviation of the dimension "B" is usually pozitive, i.e. the dimension "B" is increazed due to wear of bearing seat in the aluminium housing, and consequently, as shown in above Table, on refitting differential gear a thicker shim shout be fitted on the bearing seat. <u>The oil slinger should be 1 mm thick.</u>

- On refitting differential gear, fit firstly into bearing location the oil slinger then the adjusting shim, whose thickness was established prior, using V 104 measuring device, provided with a dial gauge, as well as the Table XXII, and finaly press over both components the outer bearing race, on a hydraulic press, using D 129 mounting device.
- On the same D 129 device press also the race of outer driving pinion bearing.
- Using S 139 bushing and a hydraulic press, fit inner bearing race on the driving pinion (see Fig. 4. 119).

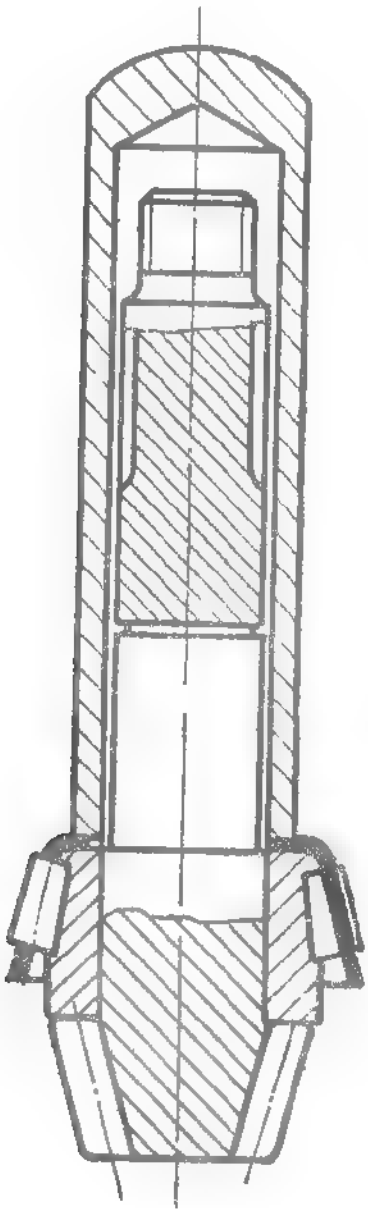


Fig. 4. 119. PRESSING DIFFERENTIAL CASE BEARING INNER RACE

- Fit on driving pinion shaft its washer and over it the standard V 106 washer, having a thickness of 1.95 mm.
- Now, introduce driving pinion from inside the differential housing and, by means of D 131 pressing device, press upon the shaft the outer bearing.
- Fit over the bearing the oil slinger and the driving flange and secure the flange tightening the nut, up to refuse, blocking the flange by means of D 116 locking device.
- Now, measure axial play of driving pinion, pressed axially with a force of 250 daN (550 lbs.). The axial play is measured with V 107 checker, and, depending on the measured play, using the below given Table XXIV, establish the thickness of the adjusting shim, which is to be fitted.

TABLE XXIV

THE TICKNESS OF ADJUSTING SHIM, DEPENDING ON DRIVING PINION AXIAL PLAY

Measured axial play (microns)	Adjusting shim thickness (mm)	Measured axial play (microns)	Adjusting shim thickness (mm)
0	1.950	500	1.450
50	1.900	550	1.400
100	1.850	600	1.350
150	1.800	650	1.300
200	1.750	700	1.250
250	1.700	750	1.200
300	1.650	800	1.150
350	1.600	850	1.100
400	1.550	900	1.050
450	1.500	950	1.000

- After having selected the adjusting shim with right thickness, unscrew the nut and remove the driving flange from the pinion shaft.
- Remove the driving pinion, by slight tapping, and replace the prior selected shim

- Press over the outer pinion bearing the annular oil seal using S 128 mandrel, after havring lubricated the bearing with RUL S 140 grease.
- Fit driving pinion again in the differential housing, the outer bearing, the oil slinger and finaly the driving flange, as already above described.
- After tightening the nut, secure it with fixing washer and snap ring. After this mounting the driving pinion should rotate without local resistance, which shlould be measures by means of V 108 checker.

The resistant moment should be within the limits from 0.016 to 0.020 m. daN (0.115 - 0.145 ft.lbs).

Before measuring tap the driving pinion in both senses, using a hammer and rotating pinion at the same time.

In case that the necessary device to measure axial play under axial pressure is not available, the right position of driving pinion will be established by successive trials, each time with shims of different thickness and estimating each time the resulted axial play, which should net exceed 0.03 mm.Finaly you should obtain, on rotating driving pinion, the above indicated value limits.

OP. 4.1.23.07.0 REFITTING & ADJUSTING DIFFERENTIAL GEAR CASE ASSY

- Fit temporarily the small cover on differential housing.

For a good operation the crown wheel pisition should be precisely determined, so that the clearance between the flanks of driving pinion and crown wheel toothing should be within the limits from 0.1 to 0.2 mm.

For the worn components witch should be replaced by new ones, whose dimension figures are different from initial component, the thickness of adjusting shims should be determined on refitting differential gear case assy. For this, proceede as follows:

- Introduce in the differential housing, upon the small cover thrust collar the special washer (thickness 0.6 ± 0.02 mm) V 109, and over it a ring made of 2 mm diameter lead wire, the diameter of the ring being about 75 mm. Fit over the load wire ring the outer bearing race.

- Fit on the differential gear case bearings, by means of S 129 hollow drift (see Fig. 4.120).

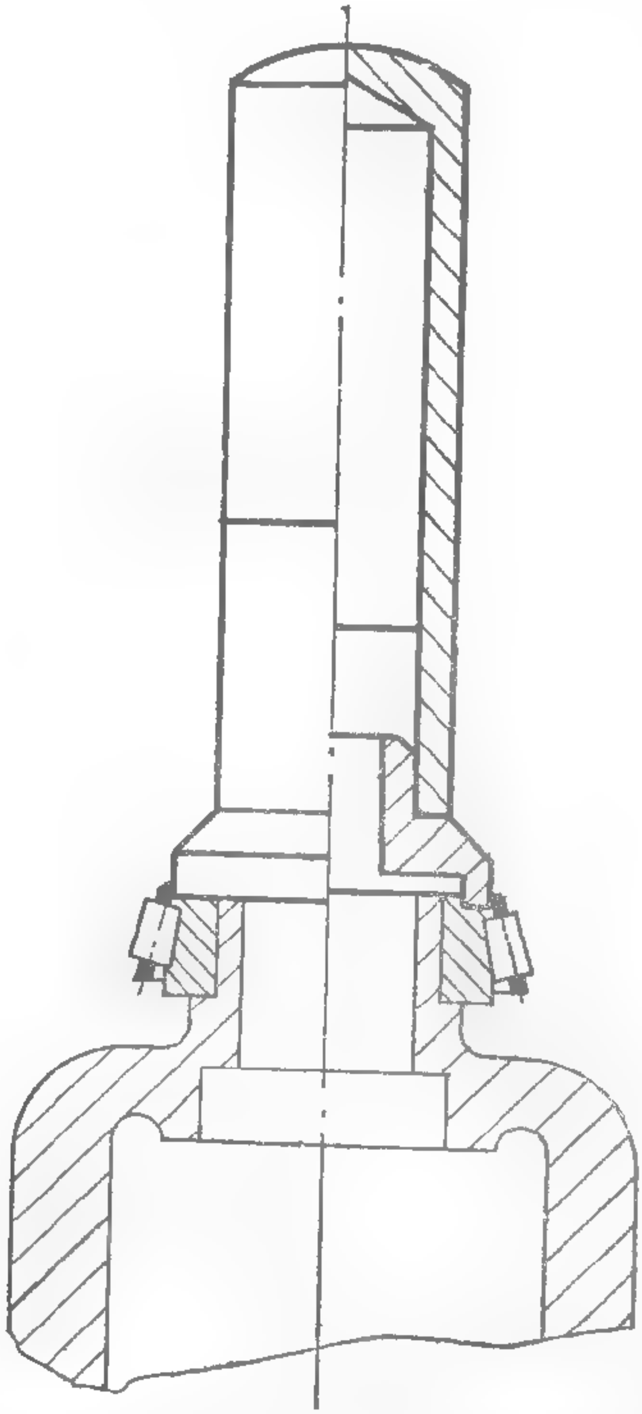


Fig. 4.120. PRESSING DIFFERENTIAL CASE BEARING INNER RACE

- Fasten differential gear case assy by the agency of S 130 special pliers and introduce it carefully into differential housing.
- Fitover the bearing thrust collar of the big cover a special V 109 washer and over it a lead wire ring (identical with the above mentioned ring). Fit over the wire ring, attentively, the outer race of the gear case bearing.
- Fit the big cover, so prepared, on differential housing and tighten nuts until both mounting surfaces contact closely, rotating at the same time the driving pinion.

In this situation the lead wire is flattened, while the clearance between driving pinion and crovn wheel is null.

- Now, remove carefully V 109 special washer and the lead wire ring, measuring thickness of the latter by means of a micrometer.

  Now, for the small cover, add to the lead ring thickness 0.72 mm, and for the big cover add to the lead ring thickness 0.58 mm.

  The resulted values will be rounded off, in addition, respectively to diminution up to a multiple of 50 microns: the resulted vaules indicate the right thickness of adjusting shims, in order to secure the right clearance between driving pinion and crown wheel.

  In case of serial repairs will be used, instead of lead wire rings, micrometric V 110 gauges, mounted on differential gear case, instead of two bearings.

- After fitting the shims, having the above indicated thickness, fit both covers on differential housing, shift axialy the gear case and check the clearance between driving pinion and crown wheel, using the D 132 mounting and checking device, which should be within the limits from 0.1 to 0.2 mm.

The micrometric gauges V 110 are set to "Zero" for bearing standard size. Periodicaly they should be checked and eventually reset to "Zero" using a standard caliper. The deviations indicated by two V 110 gauges should be born in mind for determinating of shim thickness

- Now, remove the covers, the differential gear case and V 110 micrometric gauges.
- Measure the width of bearings; under axial load of 140 daN (310 lb) using V 105 measuring instrument.

- Depending on both dimensions, measured on each side of differential, determine thickness of both adjusting shims, according to Table XXV.
- Going on, perform differential refitting in reverse order as on dismantling. Fit needle bearins and annular oil seals in both covers, up to their outer surface, During the refitting smear components with 413 AT 1 oil (or equivalent one). Smear annular oil seals with RUL S 140 grease (or equivalent one).
- Before fitting, check axle shafts for blows on their slots edges, which could damage the annular oil seals and hinder the fitting of axle shaft into differential side gears.
- For fastening axle shafts, the fixing sorews, which passe through both shafts, should be rotated, by means of S 125 handle, so that the screw cannot more get put from differential side gears.

When differential is completely assembled, the meashing between driving pinion and crown wheel, as well as between side ad differential gears should occur without jammings or resistance variations.

TABLE XXV

THICKNESS OF SHIMS FOR ADJUSTING CLEARANCE BETWEEN SIDE AND DIFFERENTIAL GEARS (in mm.)

Micrometric gauge indications (mm)	Bearing width (mm)								
	20.55	20.60	20.65	20.70	20.75	20.80	20.85	20.90	20.95
0	1	2	3	4	5	6	7	8	9
0.70	1.75	1.70	1.65	1.60	1.55				
0.65	1.80	1.75	1.70	1.65	1.60	1.55			
0.60	1.85	1.80	1.75	1.70	1.65	1.60	1.55		
0.55	1.90	1.85	1.80	1.75	1.70	1.75	1.60	1.55	
0.50	1.95	1.90	1.85	1.80	1.75	1.70	1.65	1.60	1.55
0.45	2.00	1.95	1.90	1.85	1.80	1.75	1.70	1.65	1.60
0.40	2.05	2.00	1.95	1.90	1.85	1.80	1.75	1.70	1.65
0.35	2.10	2.05	2.00	1.95	1.90	1.85	1.80	1.75	1.70

0	1	2	3	4	5	6	7	8	9
0. 30	2. 15	2. 10	2. 05	2. 00	1. 95	1. 90	1. 85	1. 80	1. 75
0. 25	2. 20	2. 15	2. 10	2. 05	2. 00	1. 95	1. 90	1. 85	1. 80
0. 20	2. 25	2. 20	2. 15	2. 10	2. 05	2. 00	1. 95	1. 90	1. 85
0. 15	2. 30	2. 25	2. 20	2. 15	2. 10	2. 05	2. 00	1. 95	1. 90
0. 10	2. 35	2. 30	2. 25	2. 20	2. 15	2. 10	2. 05	2. 00	1. 95
0. 05	2. 40	2. 35	2. 30	2. 25	2. 20	2. 15	2. 10	2. 05	2. 00
0	2. 45	2. 40	2. 35	2. 30	2. 25	2. 20	2. 15	2. 10	2. 05
- 0. 05	2. 50	2. 45	2. 40	2. 35	2. 30	2. 25	2. 20	2. 15	2. 10
- 0. 10	2. 55	2. 50	2. 45	2. 40	2. 35	2. 30	2. 25	2. 20	2. 15
- 0. 15	2. 60	2. 55	2. 50	2. 45	2. 40	2. 35	2. 30	2. 25	2. 20
- 0. 20	2. 65	2. 60	2. 55	2. 50	2. 45	2. 40	2. 35	2. 30	2. 25
- 0. 2	-	2. 65	2. 60	2. 55	2. 50	2. 45	2. 40	2. 35	2. 30
- 0. 30	-	-	2. 65	2. 60	2. 55	2. 50	2. 45	2. 40	2. 35
- 0. 35	-	-	-	2. 65	2. 60	2. 55	2. 50	2. 45	2. 40
- 0. 40	-	-	-	-	2. 65	2. 60	2. 55	2. 50	[illegible]
- 0. 45	-	-	-	-	-	2. 65	2. 60	[illegible]	[illegible]
- 0. 50	-	-	-	-	-	-	2. 65	2. 60	[illegible]

OP. 4. 1. 23. 07. 0 V REFITTING ADJUSTING DIFFERENTIAL GEAR CASE

- Fit de finitively the small cover on differential housing. Screw previo[illegible] the cover the threaded adjusting sleeve (variant) (6)
  - see Fig. 4. 113 V - in which was prior pressed the bearing outer [illegible] needle bearing (without inner race) and annular oil seal
- Fit the two bearing on the gear case, using S 129 holl[illegible] (see Fig. 4. 120).
- Fasten the gear cover with special S 130 pliers and introduce it attentively into differential housing.

Screw the big cover in the big differential cover and then fit the cover, over the studs, on the differential housing with the gear case in it.

- Fasten big cover on the housing.
- Mount the assembly in the V 401 clearance checking device and adjust the gear clerance by tightening, respectively slacking both adjusting sleeves (6), using special S 401 wrench, until the clearance will be within the limits 0.1 - 0.2 mm.
- Fit now the axle shafts, following the indications of Op. 4. 1. 22. 07. 0.

4.3.6. TROUBLES & REMEDYINGS OF THE FRONT AXLE

4.3.6.1. DESCRIPTION OF THE FRONT AXLE

The front axle is devided in two half-axles, completely unloaded, the conveying of driving troque being provided by two cross-propeller shafts.

The main components of the front axle are: (see Fig. 4.121).

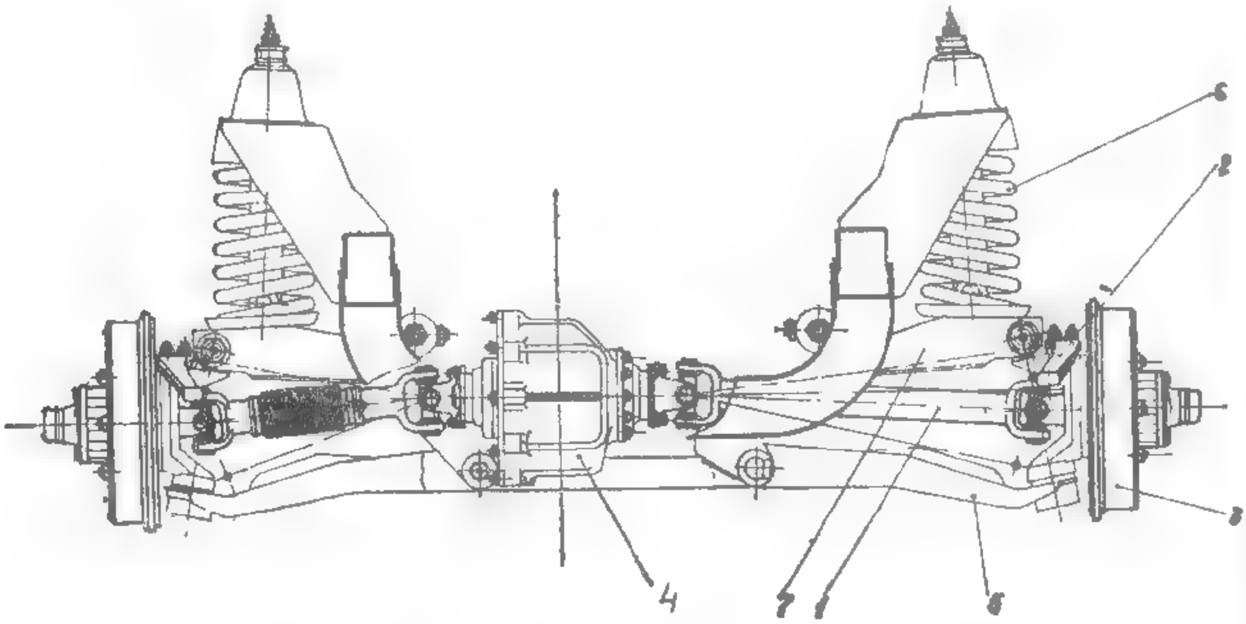


Fig. 4.121 FRONT AXLE

1- Cross propeller shaft ; 2- Drop arm? 3- Brake drum; 4- Front differential; 5- Lower control arm; 6- Coil spring; 7- Upper control arm.

- Cross-propeller shafts (1)
- Steering knucle arms (2)
- Brake drums (3)
- Brake anchor plates, bearing the brake shoes and cylinders.

The front axle track, when the vehicle is loaded up to rated load, is 1445 $\pm$ 5 mm. (4.4 ft)

The maximal conveyed power is 80 H.P.

The maximal wheel speed, on straight-line running, is 910 r.p.m.

The maximal torque, conveyed to wheels, is 270 m.daN (1950) ft.lbs).

For lubricating the wheels use only a high quality grease on lithium base, having the droping point at 140^{o}C (288^{o}F).

The maximum allowed imbalance of the brake drum assembled with the wheel hub should not exceed 0.04 m. daN (0.29 ft.lbs.).

During the operation the maximal allowed temperature of the brake drum should not exceed 60^{o}C (140^{o}F), in the bearing area (for an ambient temperature of 20^{o}C (68^{o}F).

4.3.6.2. TROUBLES & REMEDYINGS OF THE FRONT AXLE

TABLE XXVI

TROUBLES OF TRANSMISSION

Observed trouble	Necessary remedying
Cross-propeller shafts vibration	Check the clearances and replace the worn components.
Wheel lateral play.	Tighten correctly the wheel bearings.
Decreased braking efficiency, due to lubricant penetration into the brake drum	Clean the brake drum and check it; if damaged, replace the hub annular oil seal.
Exccessive overheating of the wheel bearings	Check tightening of bearings and their lubricating.

TROUBLES OF WHEEL BRAKES

Observed trouble	Necessary remedyng
Decreased braking efficiency and brake fluid leakage traces.	Check brake pipe connections, brake cylinders and their seals condition.
Decreased brak ing efficiency, due to brake fluid leakages.	Check condition of brake shoes and of their self-adjusting.
The brake gets efficient only after more than a single depressing of brake control pedal.	Remedy faulty brake self-adjusting system.

The cross propeller shafts are of similar design as the longitudinal ones, with the difference that instead of the second flange the shafts are connected with the steering knuckle (see Fig. 4. 111).

Besides the troubles, described in the 4. 3. 4, other troubles can occur in the steering knuckle. Namely, in case of insufficient lubrication of needle bearing, suuporting the steering kunckle in the outer flange of the front axle, can appear excessive wears or seizings on the working area of the needle bearing.

Abnormal wears can also occur in the sealing area of annular oil seal.

The dimensions of the steering knuckle, in the two zones, are: $\varnothing$ 30 - 0. 013 mm, respectively $\varnothing$ 60 - 0. 190 mm.

Perform dismantling of the front axle depending on observed trouble, so as to remove only the strictly necessary components.

4.3.6.3. OPERATIONS FOR REMEDYING THE FRONT AXLE

OP. 2.0.30.02.0 TAKING CROSS PROPELLER SHAFT DOWN FROM THE BRAKE DRUM AND FRONT DIFFERENTIAL

- Lift the vehicle on a 2 ton jack and take the wheel down.
- Remove axle cap and O-ring seal, using S 121 extractor (see Fig. 2.10).
- Undo and remove the split pin, securing the nut of steering knuckle.
- Unscrew the nut securing connecting flange (6) and steering knuckle shaft (13).
- Unscrew bolts fastening connecting flange on the brake drum hub and remove the flange and its gasket.
- Undo lock plate blade, securing the nut which fasten the bearing and unscrew the nut by means of S 103 special wrench.
- Take brake drum down by means of D 101 extractor.

NOTE: Take special care for utmost accuracy of this operation, in order to not introduce impurities in the bearing grease.

- Remove from the outer flange (10) the inner bearing race, by means of D 102 extractor.

  In case that on taking down the brake drum the annular oil has been damaged, remove the latter, using D 103 extractor and replace the seal, by means of mandrel.
- Drain brake fluid from the brake system, acc. to Op. 2.0.35.04.1.
- Remove connection between upper brake cylinder and brake system connecting pipe.
- Unscrew bolts fastening brake anchor plate and outer flange on steering knuckle support and remove brake anchor plate.

  WARNING On taking outer flange down perform the operation with much attention, so as to not damange the needle bearing, fitted in the flange.

- Getting access from underside of vehicle, undo lock plates, securing the bolts which fasten the cross propeller shafts to front differential flanges (in order to be able to rotate propeller shaft, disengage the front axle from transfer box).
- Remove bolts connecting cross propeller shaft to front differential and remove also the gasket.
- Remove cross propeller shaft, withdrawing the steering knuckle (18) through its support opening.

  The L.H. long propeller shaft can be also removed without dismantling the brake drum and the brake anchor plate; but, as the refitting is quite difficult it is advisible to dismantle howewer the brake drum, as above described.

On refitting propeller shafts perform the above stages in reverse order, taking special care for the following:

- After refitting the outer flange and brake anchor plate, refit the brake drum after having pressed the inner race of bearing upon the outer flange, by means of S 107 hollow mandrel.
- After brake drum refitting screw in and tighten the bearing securing nut (7) - see Fig. 2.10 -, until the drum cannot be rotated; then slacken the nut about 1/4 of a turn, so that the drum could be rotated easily, but without any perceptible axial or radial play.

  In this position secure the nut (7) by bending over it the blade of the lock plate (8).
- Introduce in the drum hub, between both bearing, RUL S 140 grease (or equivalent one).
- Tighten now the nut (3), securing connecting flange on steering knuckle shaft when respective wheel is turned to the inner extreme position.
- After connecting the flexible pipe to upper brake cylinder, perform bleeding of the brake system, acc. to Op. 2.0.35.04.1.

OP. 2.0.30.03.0 DISMANTLING & REMEDYING THE BRAKE CYLINDERS

- Lift the vehicle on a jack and take down respective wheel.

- Unscrew countersunk bolts (12) - see Fig. 2.10 - and take brake drum down from the wheel hub(14) - see Fig. 4.12. -
- Remove the brake drum from the wheel hub, paying much much attention because the clearance between both components is very closed.
- ınspect and determine which of both cyiliders has fluid leakage.
- Drain the brake system, according to Op. 2.0.35.04.1.
- Disconnect brake cylinder from feed line (if it is the upper cylinder) and from connectir g pipe between both cylinders.
- Unscrew bolts fastening the brake cylinder on the brake anchor plate.
- Remove the brake shoes by means of D 122 shoe dismantling device in order to get brake cylinder free.
- Remove from brake cylinder its protecting boot (2) - see Fig. 4.122 - then, successively, brake piston (3), piston cup (4), spring seat and brake cylinder spring.
- Clean all components by washing them only in clean brake fluid; if another organic solvent will be used for washing components, they should be obligatory wip ed dry after that.

  REMARK: In order to facilitate the fitting of the piston cup it can be prior immersed in the clean brake fluid.

WARNING: Do not mix the brake fluid, existing in the vehicle brake system, with other fluid of different quality !

- On refitting brake cylinders, perform the above stages in reverse order.

The refitted brake cylinder should be tested under a pressure of 90 daN/cm^2 (1280 lb/in^2). (See Chapter 4.5: Brake system of vehicle).

OP. 2.0.30.04.0 DISMANTLING & REMEDYING THE BRAKE SHOES

In case that the working surface of the brake shoes got soaked with lubricant, due to above described troubles, but which have been remedied, the shoe surface should be ground using a fine grit abrasive bel (be careful not to cause by grinding a deviation from the shoe cylindrical shape exceeding the

maximum allowed limit of 0.1 mm). This deviation is checked by means of V 103 measuring device.

- To check cylindrcity of brake shoes take down the wheel and the brake drum, acc. to Op. 2.0.30.03.0.
- If excessive wear of brake shoe ferrodo linings is found out, it is necessary to replace the linings by new ones. For this:
- Take down the wheel, the brake drum, the brake ancohor plate and the outer flange, acc. to Op. 2.0.30.03.0.
- Then fit brake anchor plate (see Fig. 2.40) in D 123 monting device.
- Successively remove the shoes at both ends from both cylinder seats.

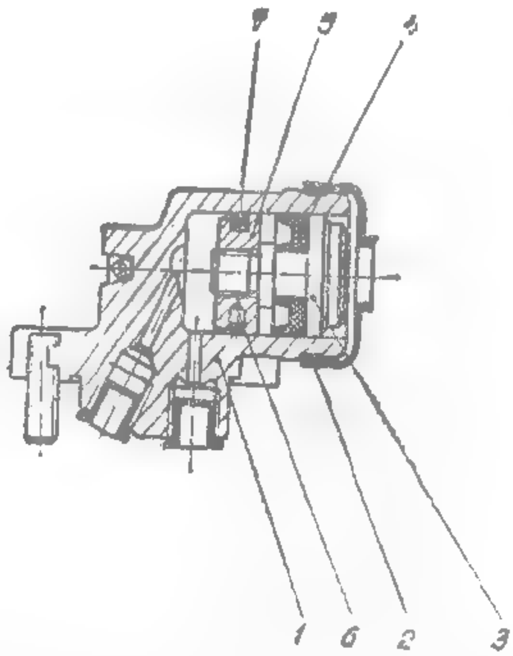


Fig. 4.122. FRONT WHEEL BRAKE CYLINDER
1- Cylinder body; 2- Brake cylinder boot; 3- Brake piston; 4- Piston rubber cup; 5- Shoe clearance self-adjusting mechanism nut; 6- Annular spring positioning pin; 7- Annular spring.

- Remove retracting spring (4) and the opposite brake shoe.
- Replace ferrodo linings of the brake shoes, by riveting new lings on the brake shoes.
- Now, fit in right position the firts brake shoe, having its both ends introduced in the cylinder slots. Fit retracting spings in the already fitted shoe and in the

second, free shoe, introducing after that both ends of the second shoe in the brake cylinder slots.

- The rest of refitting is performed in reverse order as on dismanling.

OP. 2. 0. 34. 05. 0 REMEDYING THE SHOE CLEARANCE SELF ADJUSTMENT

In case the brake is not efficient on first pedal depressing and ne fluid leakages or air in the brake system have been found (springy pedal), check the system of self adjustment of clearance between ferrodo linings and brake drum. For this:

- Lift the vehicle on a jack and take down the wheel.
- Remove the rubber plug from the brake drum, and through the hole which got free, using a feelor gauge set, check the existent clearance between the drum ferrodo lining; the clearance should not exceed the value of 0. 15 mm. This chec-king should by performed in more than one point, by turning the drum. In case the clearance value is exceeded, proceed as follows:
- Take down the wheel and the brake drum, acc, to Op. 2. 0. 30. 03. 0.
- If an excessive wear of ferrodo linings will be found out, replace the worn linings by the new ones.
- Remove from the brake anchor plate the brake shoes and brake cylinders.
- Replace the brake anchor plate, assembled with self adjustemtn system or replace both brake cylinders.

On refitting performe the above stages in reverse order.

4. 3. 7 TROUBLES & REMEDYINGS OF THE FREE WHEELING HUB

4. 3. 7. 1 DESCRIPTION OF THE FREE WHEELING HUB AND ITS POSSIBLE TROUBLES

The free wheeling hub is an integral part of the front axle.

It serves to engage and disengage the driving of the front wheels.

The engaging and disengaging of the front wheels is performed by rotating the control disc, from position 4 x 4 in position 4 x 2.

Its main components are: (see Fig. 4.124)

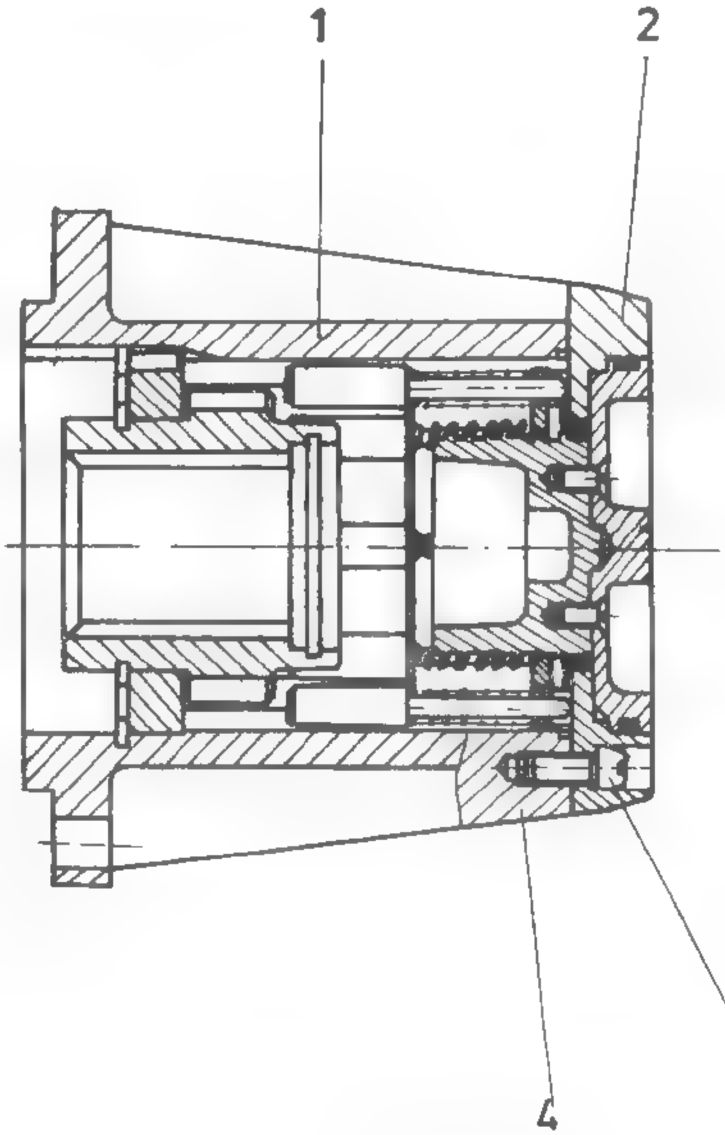


Fig. 4.124. FREE WHEELING HUB ASSY
1- Free wheeling hub body; 2- Actuating mechanism assy; 3- Fastening bolt; 4- gasket.

- The hub body (1)
- Sloted hub (2)
- Bronze bushing, immobilized in the hub by a parallel key (4) - see Fig. 4.125 - and a hub locking ring (5).

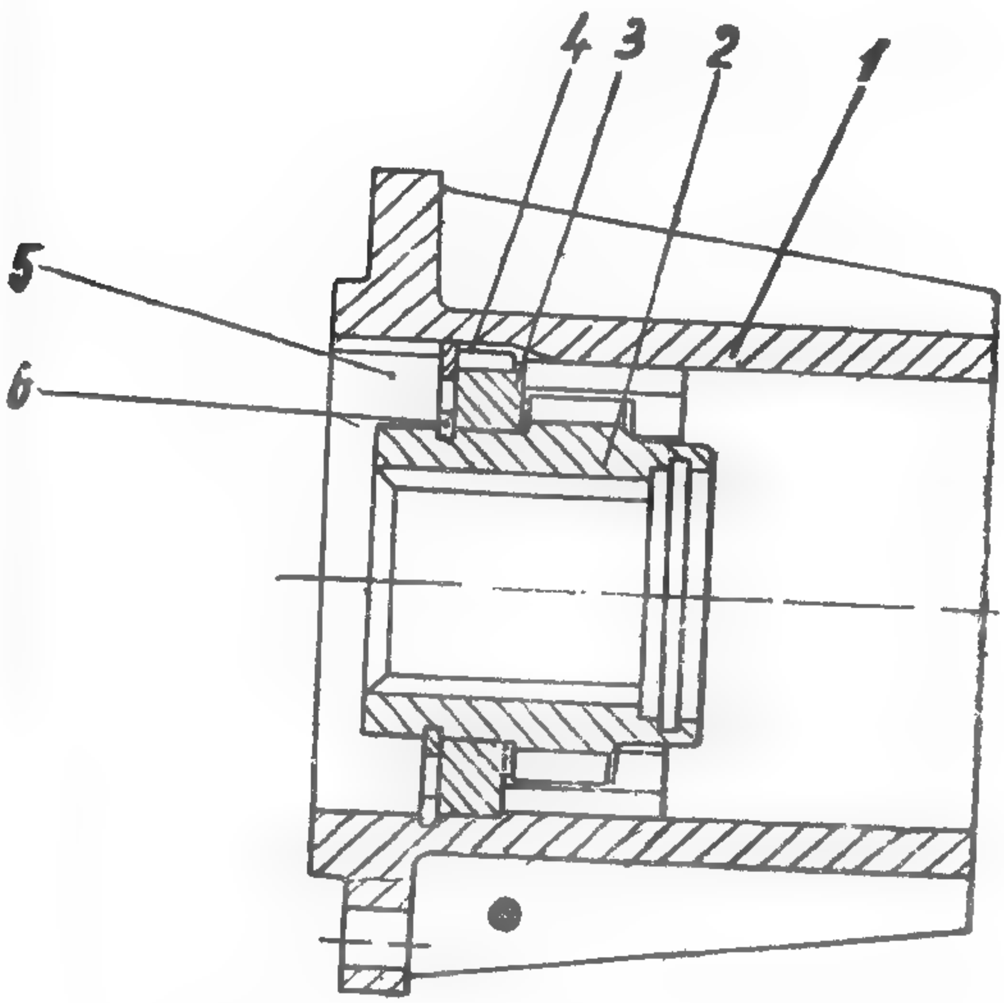


Fig. 4.125. FREE WHEELING HUB MECHANISM BODY ASSY
1- Mechanism body, 2- Slotted hub; 3- Bushing; 4- Parallel key; 5- Hub lock ring; 6- Shaft lock ring.

- Wheel driving mechanism, (see Fig. 4.126), consisting of;
- Engaging mechanism (3)
- Threaded bushing (4)
- Control disc (2)
- Cover and its fastening elements (1).

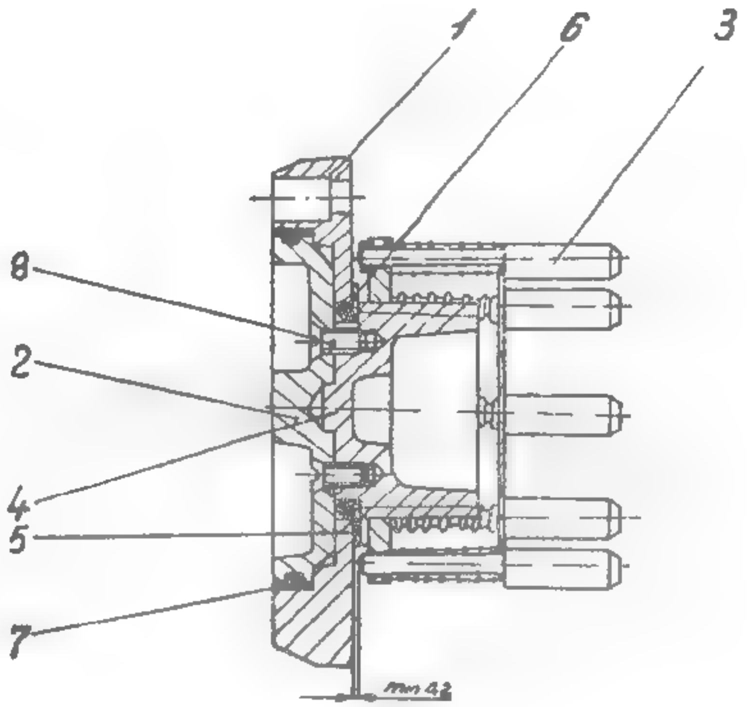


Fig. 4.126. CONTROL MECHANISM ASSY
1- Cover; 2- Control disc; 3- Control mechanism;
4- Threaded bushing; 5- Washer; 6- Sealing ring ;
7- Sealing ring; 8- Fastening screw.

It is advised to provide this free wheeling hub on vehicles of formula 4 x 4, because on driving on maintained roads the free wheeling hub leads to minimal wear of front axle transmission, to minimal effort in driving the vehicle and to its increased performances.

Between possible troubles, during vehicle operation, can occur the following:

- The wheel does not disengage, although the control disc is in 4 x 2 position. The cause of this trouble is shearing of one of the driving mechanism fingers or incorrect assambling of the mechanism.

- Premature wear of moving components, due to lack of lubricant.

4.3.7.2. OPERATION FOR REMEDYING THE FREE WHEELING HUB

- Turn the disc in its 4 x 2 position.
- Remove the five screws fastening the hub cover.
- Remove the driving mechanism assy from hub body.
- Using universal pliers, undo and remove the split pin from the steering knuckle knuckle shaft and unscrew the slotted nut.
- Unscrew the ten bolts fastening the free wheeling hub on the vehicle wheel hub and remove the former.
- After remedyng the free wheeling hub, performe the above operations in reverse erder.

OP. 4.1.32.02.0 DISMANTLING THE FREE WHEELING HUB

- For replacing the worn or damaged components of the free wheeling hub the latter should be dismantled. This operation is performed on a shop bench.
- For replacing the gaskets, remove from the driving mechanism the control disc, by unscrewing the two screws.
- For replacing the slotted hub (2) - see Fig. 4.125 - remove from the hub groove the lock ring (6), using adequate pliers and remove the hub.
- For removing the threaded bushing remove from the hub body groove the lock ring (5) and the parallel key, (see Fig. 4.125).

OP. 4.1.32.03.0 REFITTING THE FREE WHEELING

On refitting, take care to fit only components in good order, which should be cleaned by washing, and wiped dry, in order to remove any traces of impurities.

- Fit firstly the slotted bushing and the key in the hub body, securing it with the lock ring (5).
- Smear the bushing inside with UM 175 Li Ca Pb 3 grease.
- After securing the bushing fit over it the friction washer (5) - see Fig. 4. 126 and fit the slotted hub inside the bushing, securing it with the lock ring (6) - see Fig. 4. 125 -, using an adequate pliers.
- Rotate by hand the slotted hub in order to check if its rotating occurs easily, without jammings,
- before fitting the cover (1) and control disc (2) smear the surfaces for O-ring seals with above mentioned grease.
- Fit the threaded bushing collar, the washer and the O-ring seal (see Fig.4.126).
- Fit in the control disc groove the O-ring seal and then, fit the disc in the cover location, in 4 x 2 positions.
- Fit cover-control disc assembly on the threaded busing and secure it with the two screws.
- Screw driving mechanism on the threaded bushing up to its travel end, without changing position of the control disc, until the nearest finger faces the mark on the cover.
- Smear with UM 175 Li Ca Pb 3 grease (or equevalent one) the driving mechanism fingers of the hub fitted inside the hub body (1) - see Fig. 4. 125.
- Fit the driving mechanism (having the control disc still in 4 x 2 position) in the hub body, taking care that the mark on the cover faces one of the hub body rib. Fasten it with the five screws.
- Check free wheeling hub operation (the hub free for 4 x 4 position ; the hub locked for 4 x 4 position).

  Usually the refitting of the driving mechanism is performed after mounting the whole assembly on vehicle wheel.

4.3.8. TROUBLES REMEDYINGS OF THE REAR AXLE

The rear axle is of rigid type, having both half axles completely unloaded.

The wheel hubs are born, each of them, on two taper roller bearings, fitted on the outer flange of the rear axle housing.
The half axles are fitted in the slined bores of the two differential side gears, while the other ends, provided with flanges, are connected with the wheel hubs (see Fig. 4.127).

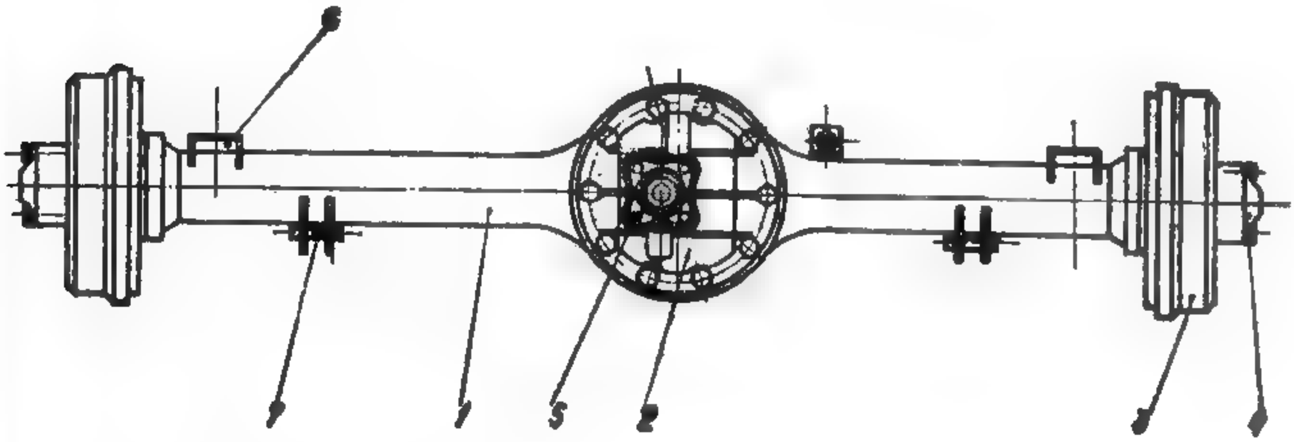


Fig. 4.127. REAR AXLE ASSY
1- Rear axle housing; 2- Differential gear assy; 3- Brake drum hub; 4- Differential half-axle; 5- Propeller shaft connecting flange; 6- Rear spring bracket; 7- Shock absrober bracket.

- Rear axle track is 1455 ± 5 mm (the longitudinal overall dimension being 1607.5 mm.
- Maximal conveyed power is of 59 kW (80 H.P.)
- Maximal inlet speed of rear propeller shaft is 4200 r.p.m.
- Maximal torque conveyed to both wheels is 360 daN.m. (2600 ft.lb).
- Transmission ratio of the bevel gear (driving pinion/crown wheel) is 4.71, in case the car is fitted with 6.50-16 "wheels, or 5.15, for 7.50-16" wheels, while by vehicles equipped with Diesel engine, this ratio is only 3.72.
- The recommended lubricant for differential gear is 413 ATI oil (or one equivalent, as T 90 EP2).
- The recommended lubricant for the wheel hub bearings is UM 175 Li Ca Pb 3 grease.

During rear axle operation no abnormal noise should occur and the temperature in the area of the wheel bearings and wheel hubs should not excend 65°C (149°F), when the ambient temperature is 20°C (68°F).
The maximal brake drum imbalance should not exceed 0.040 m. daN (i.e. 0.29 ft.lbs).

4.3.8.2. TROUBLES & REMEDYINGS OF THE REAR AXLE

Observed trouble	Possible cause	Necessary remedying
Noise in differential	Unadjusted bevel gear, broken gear teeth, damaged bearing.	Dismantle differential and adjust bevel gear and/or replace faulty components.
Lateral play of wheels	The threaded sleeve tightening the bearings, slacken.	Tighten the sleeves and adjust bearing play.
Abnormal wheel hub heating	The hub bearing are too tightened, with no play. Lack of lubricant in the hub.	Adjust the play of the hub bearings. Lubricate the hub bearings.
Decrease of braking efficiency, with lubricant leakages.	Lubricant leakages around hub annular oil seal. Brake fluid leakages around the wheel brake-cylinders.	Replace the annular oil seal. Remedy or replace the faulty brake cylinders.
Descrease of braking efficiancy, without fluid leakages.	The ferrodo linings are worn out.	Replace the ferrodo linings.

Observed trouble	Possible cause	Necessary remedying
Brake is efficient only after depressing the pedal a few times.	Self-adjusting system does not operate correctly.	Remedy self-adjusting system, by replacing faulty components.
Loss of lubricant in differential.	Rear axle housing is not tight.	Weld respective zones and check the housing for tightness.

4.3.8.3. OPERATIONS FOR REMEDYING THE REAR AXLE

OP. 2.0.24.01.0 TAKING REAR AXLE DOWN FORM VEHICLE

- Lift vehicle by means of a jack and set its chassis on D 138 suspending bracket.
- Take both rear wheels down.
- Drain hydraulic brake system.
- Disconnect flexible pipe from T-joint, fastened on the rear axle housing
- Disconnect parking brake control cable, from the rear wheels and from the brackets, fastened on chassis frame.
- Take rear propeller shaft down and remove its geasket.
- Unscrew differential drain plug and drain oil completely; after that screw the plug in its hole.
- Remove rear shock absorbers from their brackets on rear axle housing.
- Set under the rear axle two D 138 brackets.
- Unscrew nuts fastening the rear axle, by agency of U-bolts to the rear springs, and let the axle on the two D 138 brackets.
- Remove the hand brake cable.

On refitting rear axle on vehicle perform the above stages in reverse order. Tighten nuts of U-bolts with a torque of 6 - 7 m. daN (43.4 - 50.6 ft lbs).

OP. 2.0.24.02.0 TAKING DIFFERENTIAL GEAR DOWN FROM THE REAR AXLE

For remedying the rear axle or its assemblies, fasten the axle on a work bench, by means of D 140 stand brackets.

For taking differential gear down, unscrew firstly the bolts which fasten the [illegible] flanges to wheel hubs. Then withdraw the half-axles about 100 mm outwards, [illegible] splined ends from differential side gears.

- Unscrew nuts fastening differential housing on rear axle housing and remove them together with spring lock washers.
- Remove differential gear assy from axle housing, paying attention to not knock the crown wheel of bevel gear.

  Differential gear taking down can be also performed directly from rear axle mounted on vehicle. For this, besides taking down the half-axles and differential gear, as above described, is necessary the taking down of rear propeller shaft.
- After remedying differential gear, performe refitting in reverse order as on dismantling.
- Tighten bolts fastening half-axle flanges to wheel hubs with a torque of 2,4 + 0,25 m. daN (15.3 + 1.8 ft.lbs).

OP. 3.1.24.03.0 DISMANTLING DIFFERENTIAL GEAR

- Fit differential assy in the D 141 mounting device (see Fig. 4.128).
- Undo lock wires and remove adjusting nut lock finger (7).
- Unscrew bolts fastening half-bearing caps (5)
- Unscrew and remove bearing adjusting nuts (6); remove both bearing outer races and remember mutual position of dismantled components, (in case they should not be replaced by new ones), because their mutual position participate in determining correct gear clearance.

- Remove attentively differential gear case (2), assembled with [illegible] fit [illegible]
- Further performe dismanling according [illegible] of § 4 3 [illegible].
- If necessary (wear, exccensive bearing play, etc). dismantle also the driving pinion (3). For this:
- Lock driving flange (4) position by means of D 116 locking device.
- Remove snap ring and fixing washer securing the flange nut.
- Unscrew the nut by means of a socket wrench and remove the flange [illegible] light sliding.
- Push driving pinion towards inside of housing, by slight tapping, taking care to not let it fall.
- Depress annular oil seal of outer bearing, by means of D 124 adjustable extracting device.
- Remove oil slinger, fitted over the outer bearing.
- Remove outer race of driving pinion outer bearing by means [illegible] adjustable extracting device (see Fig. 4. 114).
- Remove inner race of the same bearing by means of D 143 extracting device (see Fig. 4. 129).
- Remove outer race of inner driving pinion bearing, using also D 143 extracting device.

OP. 4. 1. 24. 04. 0 REFITTING ADJUSTING DRIVING PINION

- Fit into differential housing the oil slinger (8) - see Fig. 4. 128. -
- Set in the housing special V 111 measuring instrument and measure the dimension "B" (see Fig. 4. 130). Dimension "B" (see Fig. 4. 128) will be:

  $B = 139 \pm T$ mm (where T is dial gauge deviation).
- Measure bearing width "C", under a pressure of 150 daN (330 lbs), using V 105 measuring instrument

  The thickness of adjusting shims, "D" which are to be fitted under inner bearing, will be:

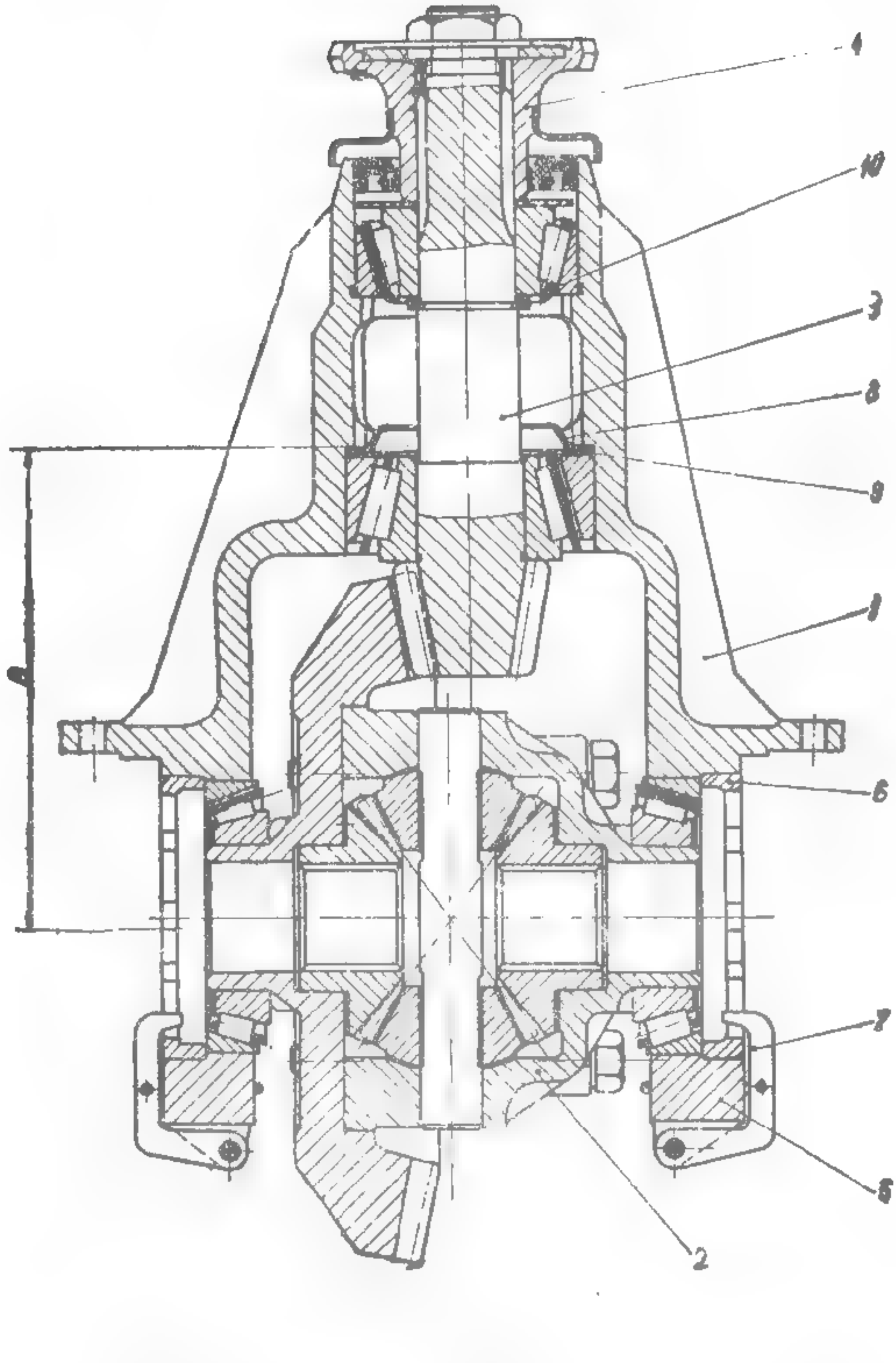


Fig. 4.128 REAR DIFFERENTIAL ASSY

1- Differential housing; 2 - Differential case assy; 3- Drive pinion; 4- Propeller shaft connecting flange; 5- Bearing cover; 6- Bearing adjusting slotted nut ; 7- Adjusting nut lock; 8- Oil slinger; 9- Drive pinion adjusting shim; 10- Drive pinion bearing; 11- Bearing washers.

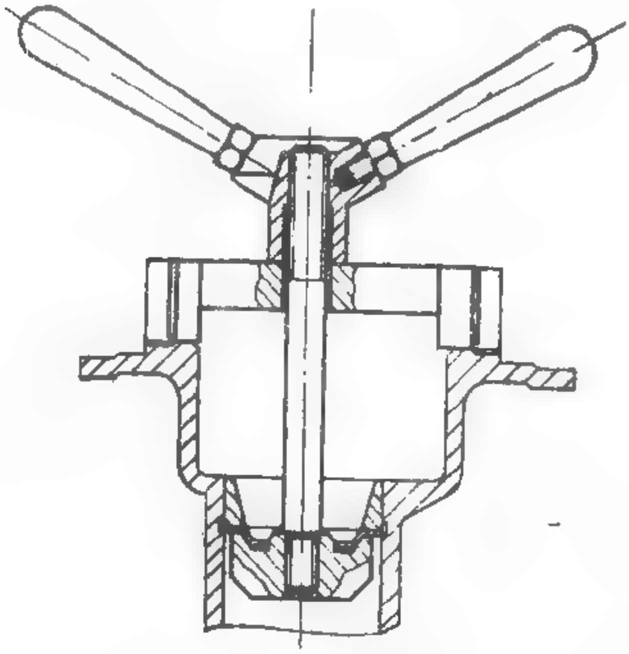


Fig. 4.129. EXTRACTING REAR DIFFERENTIAL INNER BEARING OUTER RACE, USING D 143.

D = B - (A + C) in mm.

Here A = E ± F in mm, where:

" E " is the nominal outer cone distance (i.e. the distance of the apex of the pitch up to ends of the teeth) and has a value of 112 mm.

" F " is deviation from nominal distance "E", being marked by manufacturing plant on head of driving pinion.

In case that on pinion head is nothing marked, it means that the deviation is negligible, i.e. F = 0. So, in that case it will be not necessary to take it in account on determining the thickness D of adjusting shims.

- Now, after determing and selecting necessary shim, fit it over the inner oil slinger and over it the the outer race of inner bearing (see Fig. 131), by means of S 134 mandrel.
- Fit inner race of inner bearing on the driving pinion (see Fig. 4.119), by means of S 139 bushing.
- Press outer race of outer bearing in the differential housing (see Fig. 4.132), by means of S 140 hollow drift.

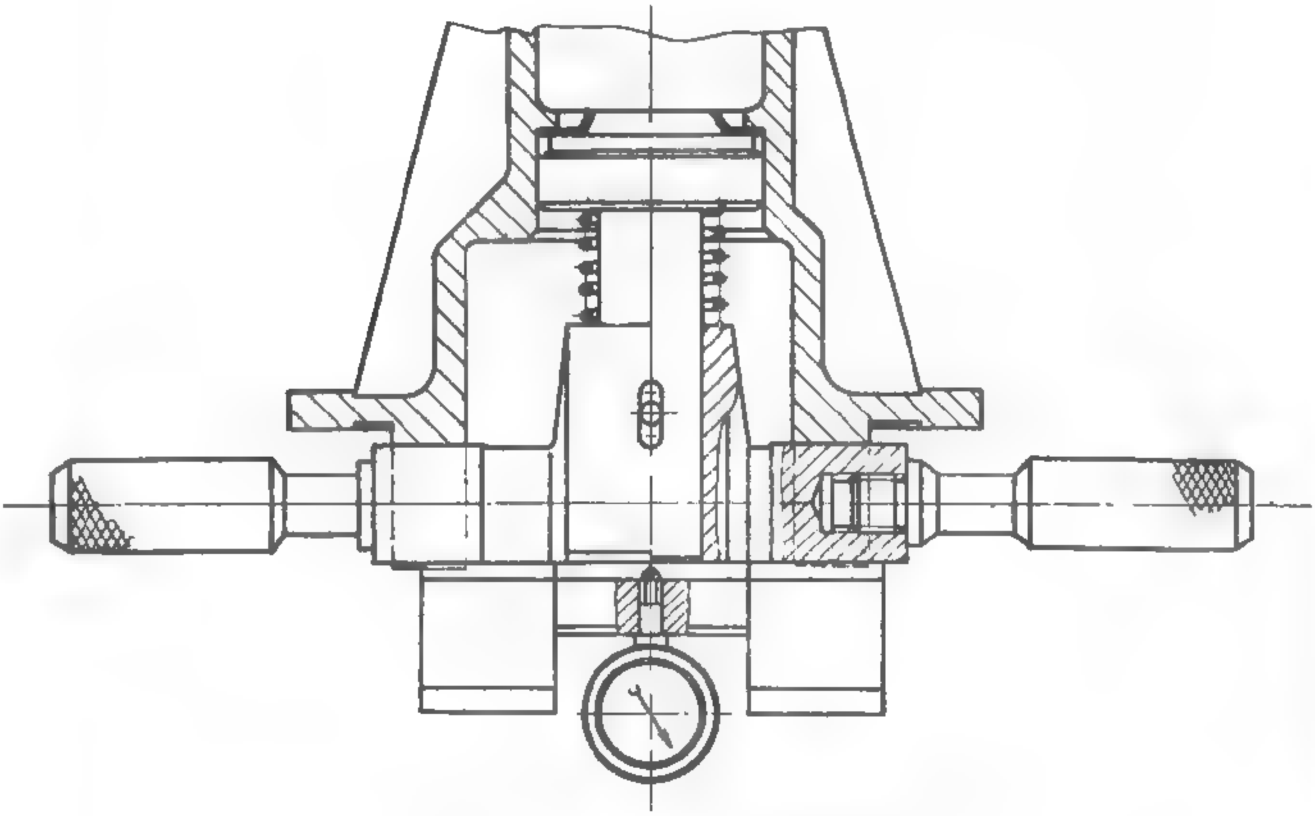


Fig. 4.130. MEASURING DIMENSION "B" BY USING V 111 CHECKER

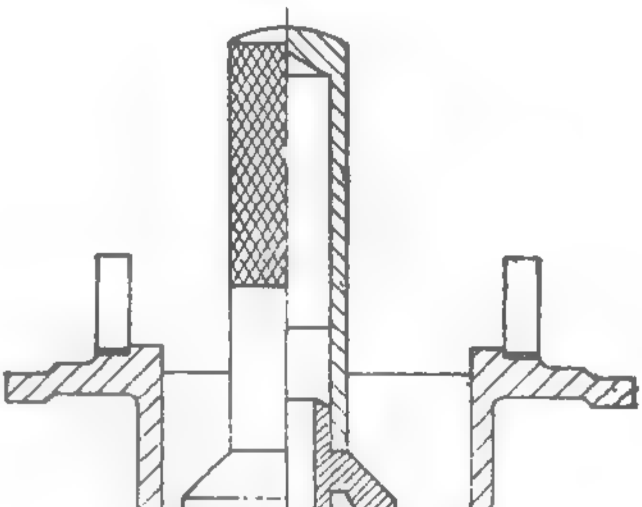


Fig. 4.131. MOUNTING DRIVE PINION BEARING OUTER RACE, BY MEANS OF S 124 DRIFT.

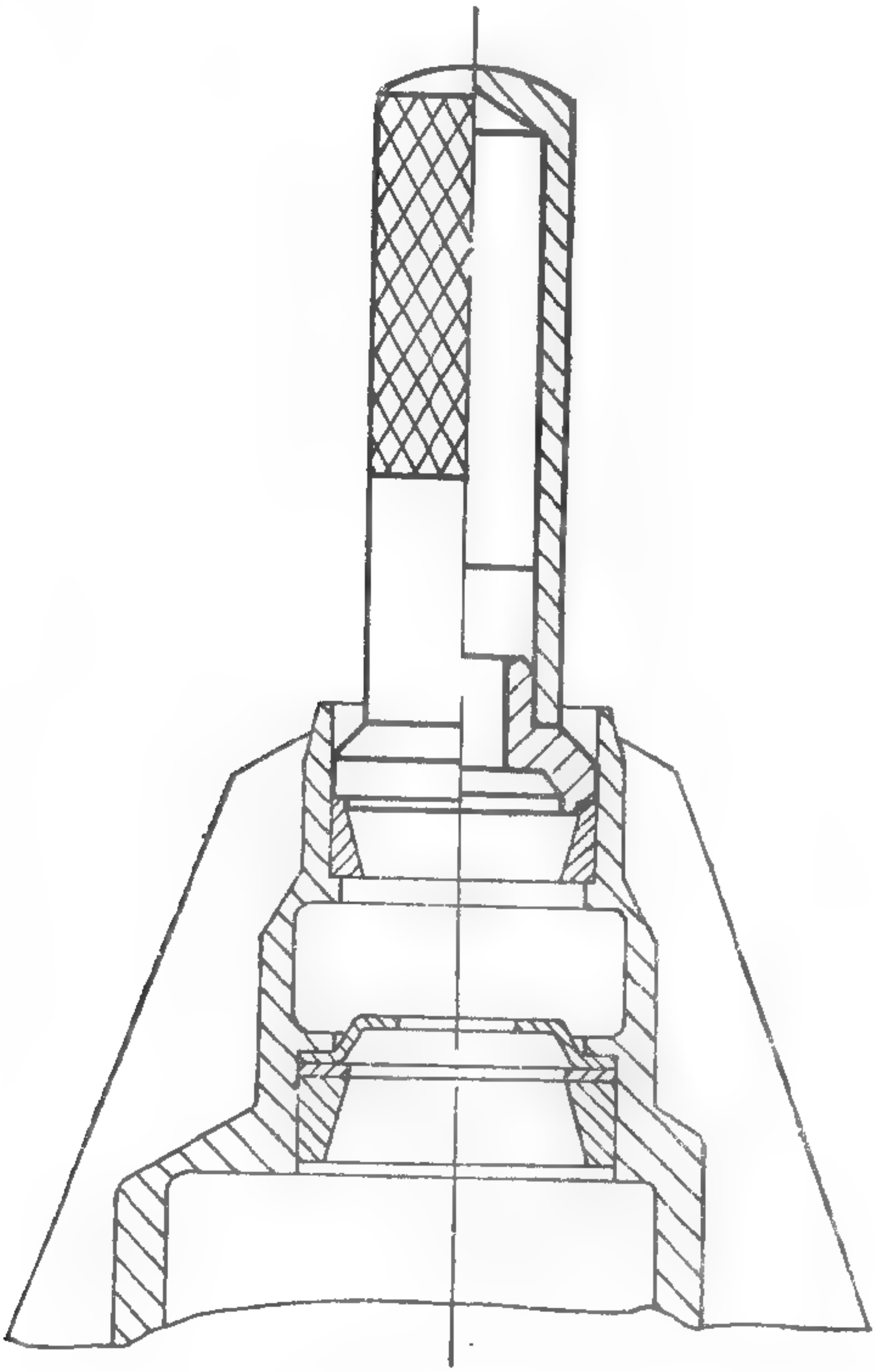


Fig. 4.132. MOUNTING DRIVE PINION OUTER BEARING OUTER RACE, USING S 140 MANDREL.

- Fit into the housing the driving pinion.

ATTENTION: In case of changing the bevel gear (driving pinion & crown wheel) take in account correlation between bevel gear transmission ratio and the size of vehicle tyres.

- Fit over driving pinion shaft its washer, then, over it the standard shim of 2.6 mm thickness and finaly the driving flange (4).

  Tighten the whole assembly with the driving pinion nut, up to refuse During the tightening of nut tap slightly pinion and simultanously rotate the driving flange.

- Fit now differential housing, assembled with the driving pinion, in the V 112 measuring device (see Fig. 133) and measure axial play of the bearings by applying a force of 25 daN (55 lbs), to and fro.
- Read on dial gauge the total play "G" in mm..
- Determine the adjusting shim thickness "H" as follows:

$$H = G + 2.60 \text{ mm}$$

- Now, unscrew the nut and remove the driving flange.
- Draw out the driving pinion through inside of housing; remove inner roller bearing race, standard shim of 2.6 mm and driving pinion washer. Raplace standard washer by shims of above determined thickness.
- Fit again the driving pinion on its place in the housing; fit on its shaft the washer, the adjusting shim (of above determined thickness), then the outer bearing and external oil slinger.

  Press in annular oil seal of driving flange, by means of S 128 mandrel, up to differential housing face.

- Fit driving flange on driving pinion shaft and secure it by tightening its nut. After tightening the nut tap slightly driving pinion, to and fro, rotating it at the samo time. Check if the nut can be tighten more.
- Secure nut position by fitting over it the fixing washer and the snap ring.
- Check the bearing tightening by measuring the rotation resistance torque, using the V 108 measuring instrument. The resistence torque value should be within the limits from 0.16 to 0.20 m.daN (1.16 - 1.44 ft.lbs).

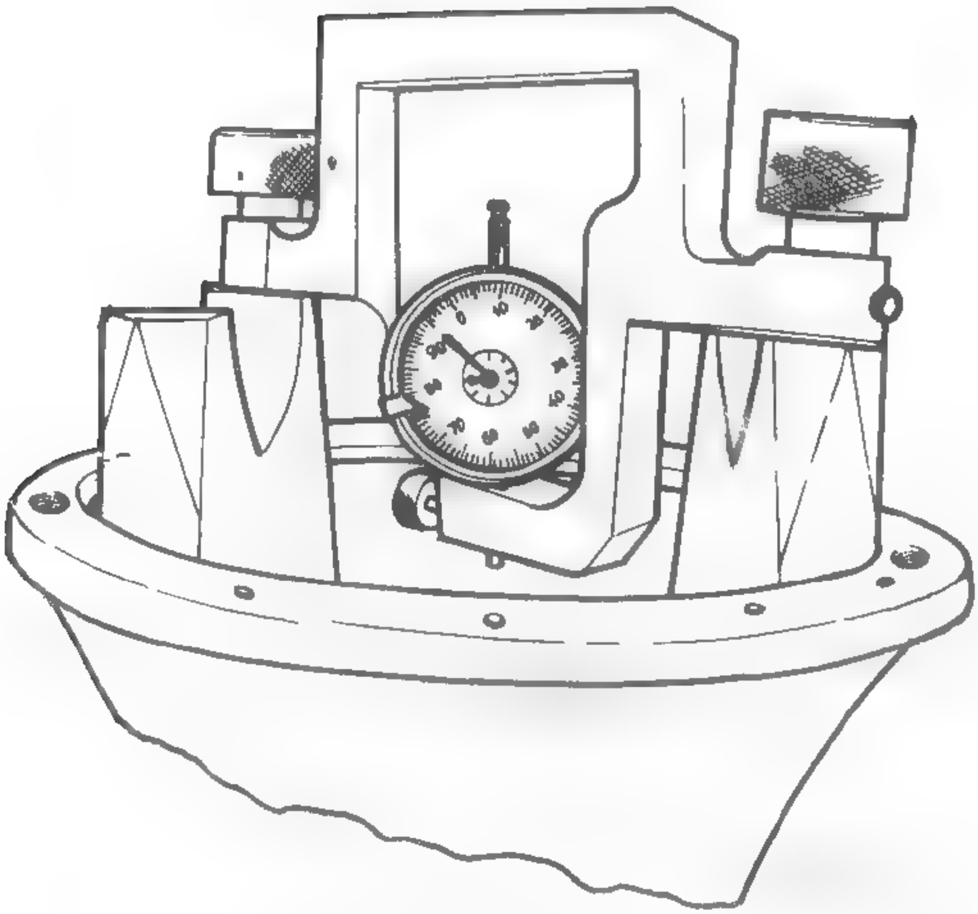


Fig. 4.133. ESTABLISHING DRIVE PINION AXIAL PLAY, USING V 111 GHECKER.

OP. 4.1.24.05.0 REFITTING AND ADJUSTING DIFFERENTIAL GEAR CASE ASSEMBLED WITH THE CROWN WEHEEL

- After reassembling differential gear case, acc, to Op. 4.1.23.07.0, refit it into differential housing. For this:

Set differential housing in the special D 144 device (see Fig. 4.134), in order to adjust the gear clearance.

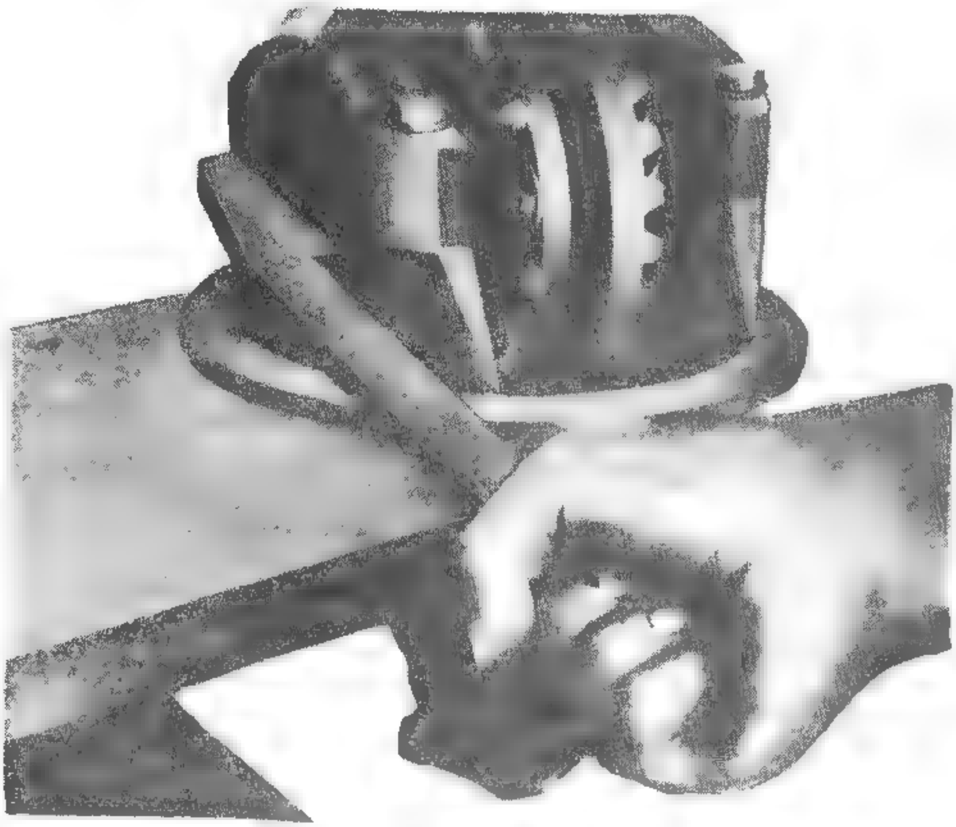
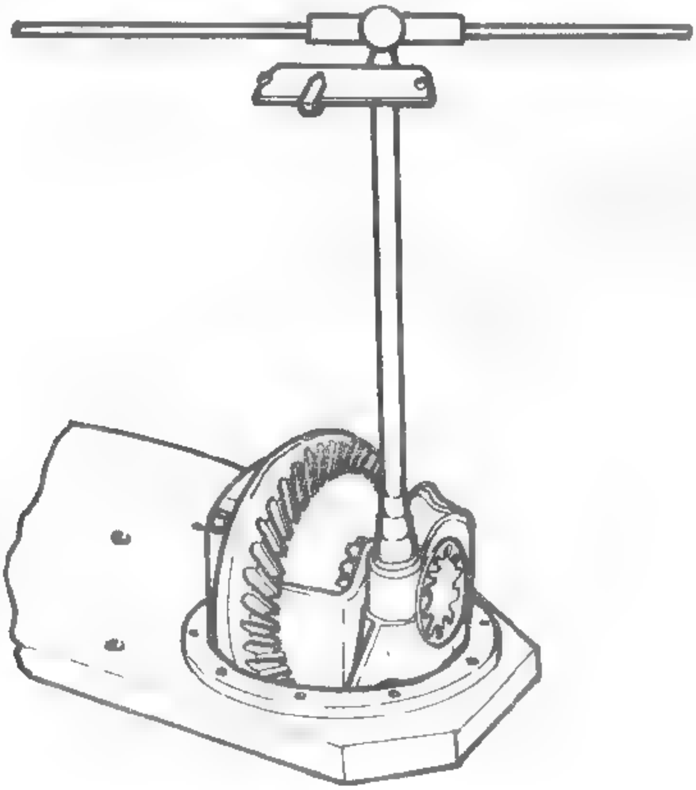


Fig. 4.134. DIFFERENTIAL GEAR CLEARANCE ADJUSTING, USING S 141 SPECIAL WRENCH.

- Lubricate driving pinion bearing and differential gear case bearings, using RUL S-140 grease (or equivalent one).

- Introduce differential gear case assy into diff. housing, the two half-bearing caps (5) (see Fig. 4.128) and screw in the two bearing position adjusting nuts (6), respecting initial mutual position of these components.
- Tighten both half-bearing caps (5) on differential housing, but without locking rotation of the two adjusting nuts (6).

Gradually turn the adjusting nut (6) on the wheel side (see Fig. 4.135), getting the crown wheel nearer the driving pinion.



- Keeping driving pinion fixed, get the crown wheel nearer it, till when measuring the backlash of the crown wheel teeth flank, it should not exceede the vaule of 0.1 - 0.2 mm (see Fig. 4.136). In this position the adjusting nut [illegible] locked (having a recess in the middle of the half-bearing cap) by final tightening of the solts, (fastening the half-bearing covers on differential housing) applying a torque of 4 - 4.5 m. daN (28.8 - 52.5 ft. lbs).
- Get the opposite adjusting nut nearer, fastening the differential gear case bearings so that no axial play should be perceptible, but letting at the same

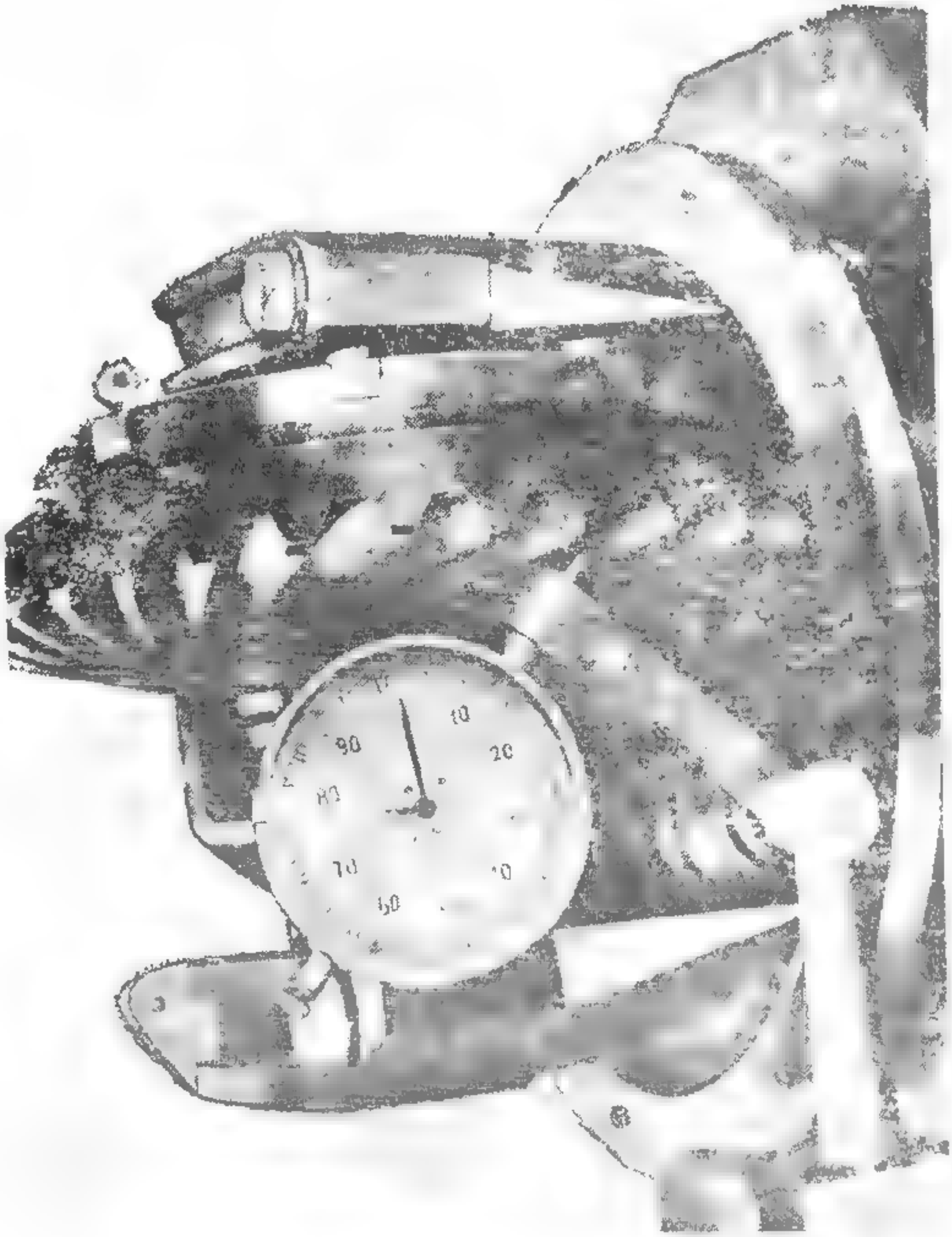


Fig. 4.136. MEASURING CLEARANCE BETWEEN DRIVE PINION AND CROWN WHEEL

time the crown wheel able to be rotated by hand, without jammings or di- fficulty (excessive effort).

Check this condition by using the special S 141 wrench (see Fig. 4.134).

In case the differential is correctly assembled and provided with components in good condition, the backlash between the crown wheel teeth flanks and those of driving pinion should not vary more than 0.05 mm for a complete rotation.

- Now, secure both adjusting nuts (6) (see Fig. 4.128) with their lock fingers (7), which are themselves locked in position by means of a wire collar.
- Finally, check correct meshing of bevel gear by inspecting the contact spot on the teeth flanks.

OP. 2.0.24.06.0 CHECKING ADJUSTING REAR WHEEL BEARING CLEARANCE

In case the vehicle has no stability on running, check clearance of the rear wheel bearings. For this,

- Lift the vehicle on a jack and in case a wheel lateral play is found out proceed in following manner:
- Unscrew bolts fastening half-axles to the wheel hub and remove both half-axles and respective flange gaskets.
- Unlock bearing adjusting nut (successively on each wheel), by unbending the lock washer blade.
- Check the play of both bearings and if it exists, unscrew adjusting nut, remove lock washer and adjust the play by agency of the second nut, proceeding as follows:
- Tighten nut and at the same time rotate the wheel hub in both senses, in order to set correctly the bearing rollers - until the wheel, getting an impulse, continue to rotate about a turn. In this situation unscrew the nut with an angle of about 30^{o} - 60^{o}. Tap slightly the wheel hub, in order to let it return the new play; now the wheel hub should turn easily, without any perceptible radial or axial play.
- Refit now dismantled components, taking care to lock both adjusting nuts of bearings.
- Finaly descend vehicle from the jack.

OP. 2.0.24.07.0 REPLACING REAR HALF-AXLES

This operation can be performed without lifting vehicle on a jack.

For do this, proceed as follows:

- Unscrew bolts fastening rear half - axle flanges to wheel hubs and remove both halfaxles by sliding outwards,
- On refitting do not force penetrating of half-axles splined ends into differential gear. In order to facilitate this operation, rotate slightly each half axle pushing it at the same time inwards, or, if the rear axle is taken down from vehicle, turn slightly the driving flange of driving pinion until the splines of each half-axle penetrate into differential side gear.
- Finaly tighten bolts fastening half-axle flanges on the wheel hubs with a torque of 2.4 + 0.25 m.daN (17.3 $\pm$ 1.8 ft.lbs).

OP. 2.0.24.08.0 REPLACING ANNULAR OIL SEAL OF THE WHEEL HUB

In case it will be found lubricant leakage from the wheel hub, which is possible only when the annular oil seal is damaged, proceed on replacing the faulty seal, in the following order:

- Lift vehicle on a jack, placed under respective wheel.
- Take down the wheel.
- Take down respective half-axle.
- Undo lock washer of the wheel bearing, using the S 103 special wrench.
- Draw out brake drum by means of D 101 extractor.
- Draw out bearing inner race from the outer flange, using D 102 extractor.
- Remove annular oil seal from the wheel hub by means of D 103 extractor.
- Remove old lubricant and wash the components with white spirit. On this occasion check both bearings for signs of wear.
- Introduce inner bearing into the wheel hub and lubricate both bearings with UM 175 LiCaPb 3 grease, or equivalent one.

- Now, press in annular oil seal, up to the hub face, using S 106 mandrel.
- Fit brake drum on outer flange by slight tapping the wheel hub.
- Tighten both bearings with the adjusting nut, up to refuse, when the drum rotation is braked; unscrew adjusting nut a quarter turn back, so that the drum could be rotated by hand, but without any perceptible radial or axial play.
- Lock adjusting nut by bearing one of the ock washer blades in the nut recess.
- Refit the rest of components in reverse order as on dismantling.

OP. 2.0.24.09.0 REPLACING BRAKE SHOES WITH WORN OUT FERRODO LININGS

- Lift respective wheel of vehicle on a jack and take down the wheel.
- Unscrew countersunk screws and remove brake drum from the wheel hub, by slight tappings, because the fit of both components is close.
- Inspect brake shoes ferrodo linings if they are not imbibed with lubricant or glazed. In both situations the linings should be cleaned and slightly abraded with emery paper on the whole its length.
- In case the ferrodo lining sufrace has got to the rivet surface, replace respective shoes. For this:
- Using two levers remove the brake shoe ends from the two recesses, get it free and take it out.

On refitting new brake shoes perform operations in the following order:

- Connect both brake shoes between them with the two retracting springs (4) (see Fig. 2.40).
- Get the springs behind the hub flange.
- Fit both ends of one the shoes in the brake cylinder and brake piston recesses, seating them on supporting components.
- Using two levers, fit the other brake shoe into respective recesses. That operation can be performed easier, after taking down prior the wheel hub with the two bearings in it.

OP. 2. 0. 24. 10. 0 REPLACING BRAKE PISTON CUPS

- Lift respective wheel of vehicle on a jack and take down the wheel.
- Take down the brake drum, acc. to Op. 2. 0. 24. 08. 0.

  If, on taking down the wheel hub its annular oil seal will be damaged, it should be replaced with a new one, as shown above (Op. 2. 0. 24. 08. 0).
- Disconnect brake fluid feed pipe.
- Remove both brake shoes,. acc. to Op. 2. 0. 24. 09. 0.
- Dismantle respective brake cylinder, by removing successively: brake cylinder boot, brake piston, piston cup (4) - (see Fif. 4. 137).

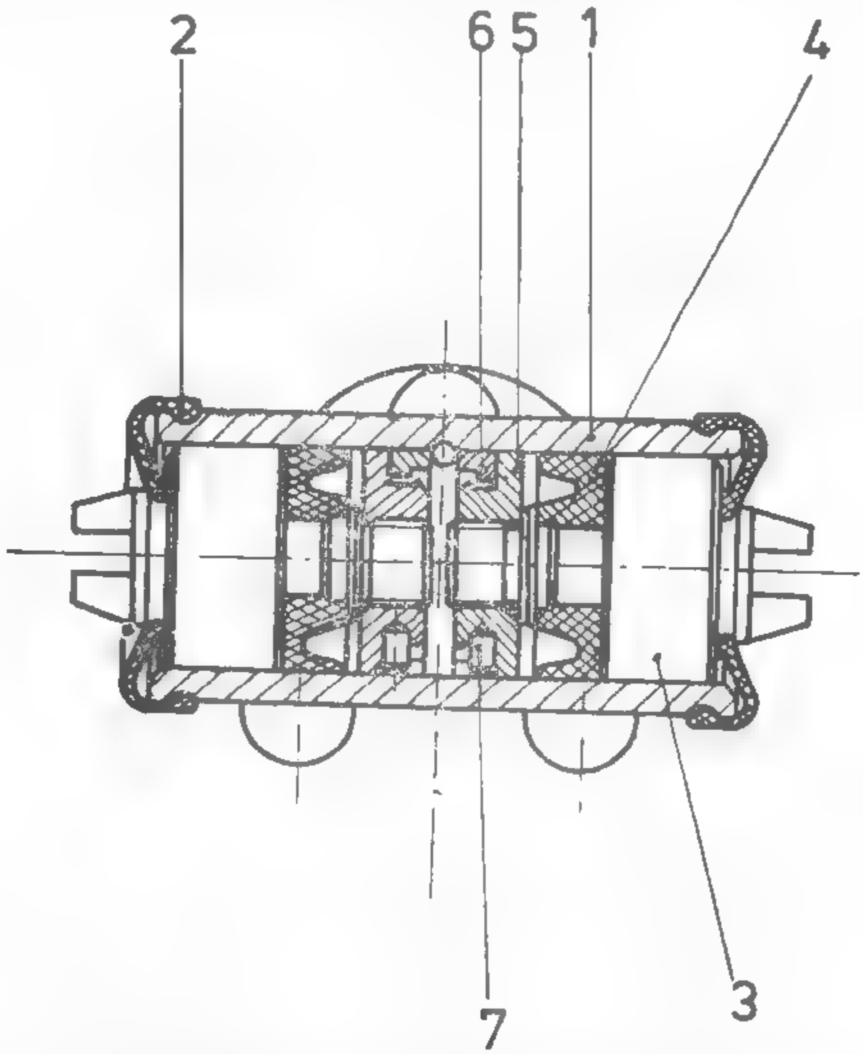


Fig. 4. 137. REAR BRAKE CYLINDER
1- Cylinder body; 2- Cylinder boot; 3- Brake piston; 4- Piston rubber cup; 5- Brake shoe clearance self - adjusting mechanism nut; 6- Annular spring ; 7- Annular spring locking pin.

- Unscrew piston nut (5) and replace faulty piston cup by a new, original one.
- Refit brake piston components in reverse order.
- Refit all components of respective wheel in reverse order.

OP. 2. 0. 24. 11. 0 REPLACING AN ULAR OIL SEAL OF HALF-AXLE

In case the annular oil seal of the rear half-axle (fitted in the rear axle housing flange) is worn out, the oil from differential housing can reach the grease of wheel hub bearings, washing the grease and causing so lubricant loss in differential housing, lubricant presence on brake shoe ferrodo linings or insufficient bearing lubrication, with respective consequences.

For replacing the damaged annular oil seal, proceed as follows:

- Lift respective wheel of vehicle on a jack.
- Take down, successively: the wheel, the rear half-axle, the brake drum assy.
- Disconnect the brake cylinder from hydraulic brake system.
- Remove hand brake cable.
- Unscrew bolts fastening brake anchor plate and outer flange and remove both components.
- Inspect annular oil seal, fitted in the end flange location of the rear axle housing. If the seal is worn or damaged, remove it by means of D 124 extractor.
- Inspect the seat of annular oil ring for scratches or pronounced blows which could hinder the outer sealing of the seal. If necessary, remove such faults by honing with a fine grit stone.
- After remedyng the annular oil seal seat, fit in a new seal, using special S 135 mandrel. The seal should be pressed up to rear axle flange face.
- On refitting, performe the above stages in reverse order.
- Tighten bolts, fastening outer flange and brake anchor plate, with a torque of 4.3 ± 0.2 m.daN (31 ± 1.4 ft. lbs.).
- After connecting the brake cylinder to hydraulic brake system perform its bleeding.

REMARK: On refitting the half-axle check its splined end for burrs, which, on passing through the oil seal, could damage its inner sealing lip.

OP. 2.0.24.12.0 REMEDYING SELF ADJUSTING SYSTEM OF BRAKE SHOES

In case the brake is not efficient on first depressing of pedal, although no brake fluid leakages have been observed and the brake system has been correctly bleeded it should be checked self-adjusting system of clearance between the brake shoes and the drum.

For this:

- Remove the rubber plug from the opening of the brake drum and measure existing clearance between brake shoe lining and drum friction surface. Checking should be performed using a feeler gauge set, first time immediately after braking and second time after a certain period of time, during which the brake has been at rest. In case there will be found no difference between the two meansurements (their value being comprised between 0.10 and 0.15 mm) the trouble should be however considered as being caused by insufficient brake system bleeding or its lack of tightness.

  In case differences between both measurements are found, or clearance exceeds the prescribed values, on the whole ferrodo lining length (the mea surement should be performed in several points, by turning the drum), that means that the automatic selfadjustment is not operating correctly, and the brake anchor plate should be replaced with a new one. For this:
- Take dwon the wheel.
- Remove rear half-axle.
- Disconnect the brake feed pipe and the hand brake cable. (These three operations should be performed in accordance with above given instructions).
- Disassembly the brake anchor plate by removing the brake shoes, the hand brake control lever and the brake cylinder.

  In order to make this operation easier fit brake anchor plate on D 123 mounting device.
- On refitting, performe the above stages in reverse order.

4.3.9. TROUBLES & REMEDYINGS OF POWER TAKE-OFF

4.3.9.1. DESCRIPTION OF THE POWER TAKE-OFF AND ITS VARIANT WITH THE BELT PULLEY

This unit is an optimal equipement of the ARO vehicles and is designed for performing different mechanical works. The power take - off conveys the rotary movement ond the driving torque from gearbox to the proper power take-off, fitted on the rear cross member of the chassis frame.

- Maximal conveyed power: 45 H.P.
- Nominal speed of power take-off shaft: 540 r.p.m.
- Rotation sense of the shaft (looking from the vehicle back): rotation in clockwise direction.

The design and dimension of the output shaft are given in the Fig.4.138.

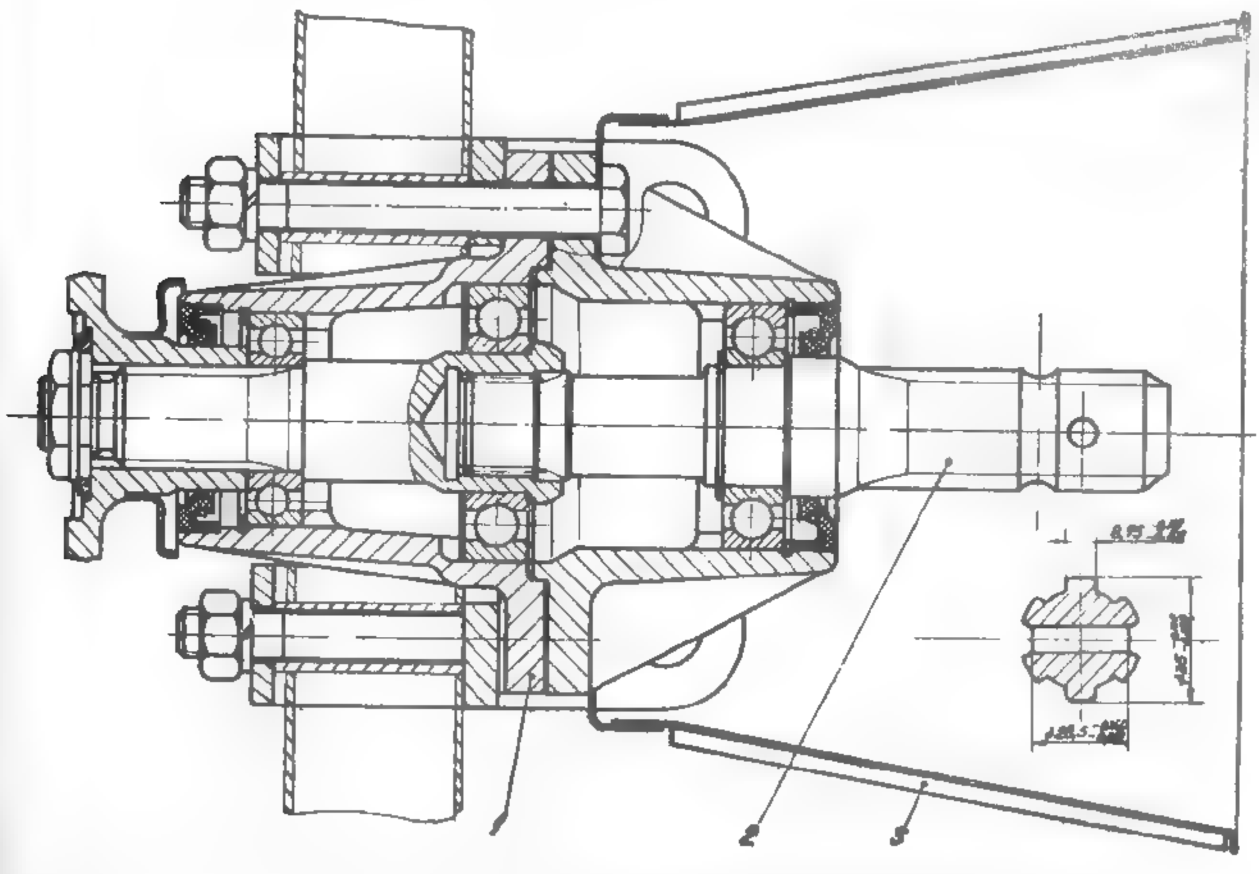


Fig. 4. 138. REAR POWER TAKE-OFF
1- Power take-off housing; 2- Power take-off outlet shaft; 3- Guard.

The whole power take-off assembly consists of:

- The proper power take-off, fitted on the rear cross-member or the chassis frame.
- The driving cardan shaft, connecting gearbox with intermediate bearing (see Fig. 4, 139).

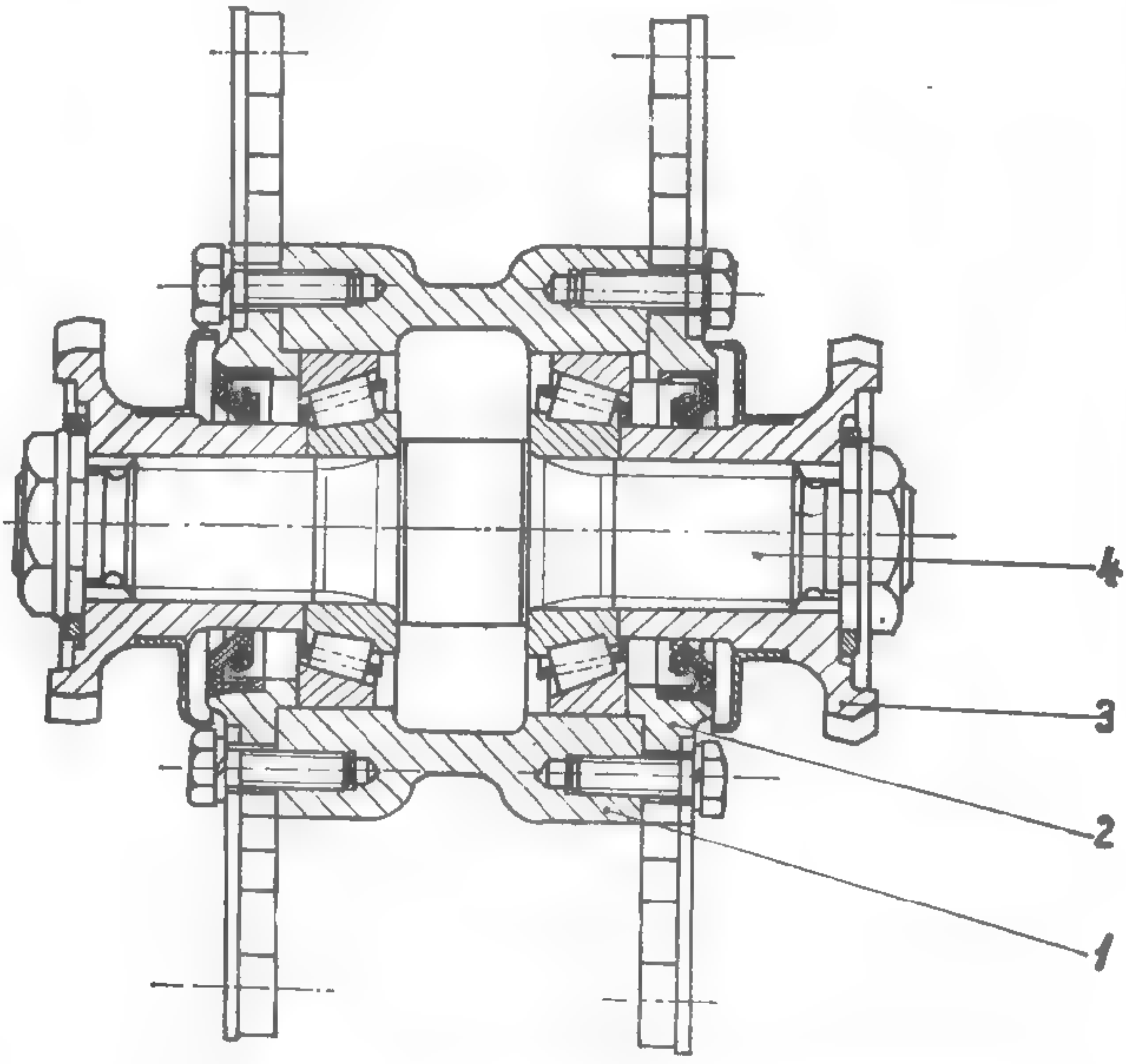


Fig. 4. 139. PROPELLER SHAFT INTERMEDIATE BRACKET
1- Intermediate bracket body; 2- Cover; 3- Propeller shaft connecting flanges; 4- Intermediate bracket shaft.

- Intermediate bearing.
- The driving cardan shaft, connecting intermediate bearing with the pover take-off itself. The intermediate bearing is fastened on the chassis frame.

The power take-off can be replaced with a belt pulley (see Fig.4.140). This pulley conveys the rotary movement at an angle of 90^{o} in keeping with the powe rake-off axis, and conveys the power by the agency of a flat belt. This uni consists of a housing, a bevel gear and the pulley.

4.3.9.2. TROUBLES & REMEDYINGS OF THE POWER TAKE-OFF, PROVIDED WITH THE BELT PULLEY

The troubles of the power take-off can occur due to an incorrect operation, as lack of lubricant, wrong fitting of the units and components, etc.

As troubles which can occur we can indicate:

- Seizing
- Vibration and noise on operating
- Excessive wears.

4.3.9.3. OPERATIONS FOR REMEDYING THE POWER TAKE-OFF

OP. 2.0.43.01.0 DISMANTLING REFITTING THE POWER TAKE-OFF

- Take down cardan shaft from the driving flange of the power take-off, using special D 115 wrench.
- Unscrew the two bolts fastening the power take off on rear cross member of the châssis frame (see Fig. 4.138).
- Remove successively protecting case (3), the rear housing of the o utput shaft, the front housing.of the input shaft and check bearing clearance and the slots of the two shafts. If necessary, dismantle the unit in order to replace the worn or damaged parts.

OP. 2. 0. 43. 02. 0 DISMANTLING THE INPUT SHAFT

- Remove snap ring securing the lock washer of the nut fastening the driving flange on input dhaft.
- Remove lock washer, securing the nut.
- Lock the driving flange und unscrew the nut.
- Draw out the driving flange.
- Remove annular oil seal from its seat (only if it is to be replaced).
- Knock slightly the flange end of the input shaft, removing it from the bearing bores.
- Draw out the rear bearing by the agency of D 117 extracting device.
- Remove snap ring and draw out the front bearing.

REMARK: In case that on drawing out the shaft the bearings have got also out, remove them from the shaft by means of S 116 extractor.

- On refitting, performe the above stages in reverse order, pressing the bearings in the front housing by means of S 117 bushing.

OP. 2. 1. 43. 03. 0 DISMANTLING THE OUTPUT SHAFT

- Remove the snap ring from the shaft (behind the bearing).
- Remove the shaft from bearing bore by slight tapping outwards.
- Draw out the bearing by means of D 117 extractor.
- In case the annular oil seal is worn remove the snap ring from the rear housing and then thea seal ring, depressing it by means of S 118 mandrel. Refit components in reverse order as on dismantling.

OP. 2. 0. 43. 04. 0 DISMANTLING AND REMEDYING INTERMEDIATE BEARING

Remove both cardan shafts from intermediate bearing flanges (see Fig.4.139) Take down intermediate bearing by unscrewing bolts fastening it on the two chassis brackets.

- Fit intermediate bearing assy in the D 118 dismanling device.
- Remove lock washers of the nuts securing the two flanges.
- Lock successively each flange and unscrew the two nuts.
- Remove both flanges from intermediate bearing shaft (4).
- Remove both bearing covers (2), together with respective annular pil seals.
- Tap slightly one the shaft ends, removing it from the bearing housing, together with one of the two roller bearings.
- Remove the other bearing from the housing by means of D 117 extractor.
- Remove the first bearing from the shaft.
- Check bearings and annular oil seals for rate of wear and replace the worn or damaged components.

  On refitting the intermediate bearing performe the above stages in reverse order as on dismantling.

OP. 2. 0. 43. 05. 0 TROUBLES & REMEDYINGS OF BELT PULLEI DRIVE

The belt pulley drive is coupled with the whole power take-off system A bevel gear conveys the rotary movement from power take-off out put shaft to the belt pulley shaft, placed at an angle of 90^{o} in keeping with the out put shaft (see Fig. 4. 140).

The troubles that can occur with this mechanism are caused by the wear of bevel pinions or bearings.

For dismantling the unit unscrew firstly the drain plug and let oil drain completely.

- Remove the belt pulley.
- Unscrew bolts fastening the unit housing on the vehicle.
- Remove the housing cover.
- Remove split pin and nut from driving shaft (2).
- Remove snap ring from driving shaft outer busing.
- Knock slightly driving shaft outwards in order to make access to driven shaft (3) nut.

Remove split pin and nut from driven shaft (3).

- Konck slightly driven shaft outwards until it gets out from bearing bores.
- Remove driven bevel gear, then adjusting shim and finaly the driving bevel gear

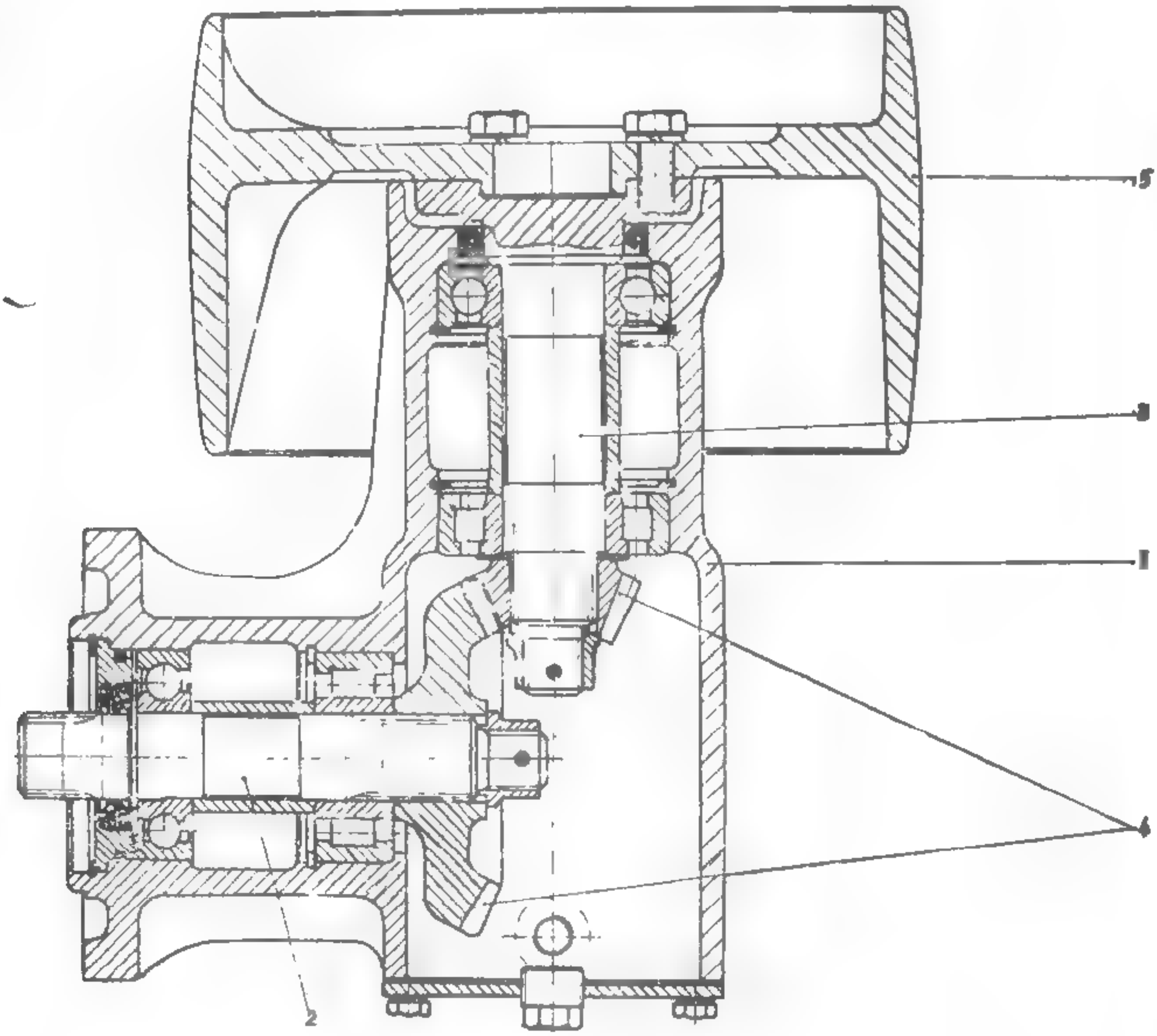


Fig. 4.140. POWER TAKE-OFF BELT PULLEY
1- Housing; 2- Main shaft; 3- Driven shaft; 4- Taper gear;
5- Belt pulley.

Draw out inner bearing from driven shaft, by means of D 147 extractor.

- Remove both bearing snap rings, by means, of special S 136 pliers, and finally the spacer bush.
- Draw out the second bearing of driven shaft, using D 147 extractor.
- Remove annular oil seal of driven shaft, by means of special S 137 mandrel.
- Knock slightly driving shaft outwards until it gets out from bearing bores. In case the sealing ring bushing has not been removed together with the shaft, introduce the extracting device through spacer bushing recesses between the bearings and remove the bushing together with the outer bearing.

  Between the outer bearing and the annular oil seal holding bushing is fitted the shim for adjusting the driving bevel gear position.
- Using S 136 pliers remove the snap ring and, by means of D 147 extractor draw out the inner bearing of driving shaft.
- If necesary, replace annular oil seal, using S 138 mounting mandrel.

On refitting, performe the above stages in reverse order.

In case of replacing bevel gear, check the meshing backlash, which should not exceed 0.2 mm. along the whole periphery of the bevel gear, as well as the gear contact spot.

The right adjusting is obtained using a set of shims for both bevel pinions.

On tightening nuts securing the two bevel pinions apply torque of about 20 m. daN (144,5 ft, lbs).

4.4. THE VEHICLE STEERING SYSTEM

4.4.1. DESCRIPTION AND OPERATION OF THE STEERING SYSTEM

The steering system of ARO vehicle is of trapizoidal, devided type and is located in front of the front axle (see Fig. 4.141). It consists of :

- Steering gear box
- Steering pivot
- Steering linkage
- Steering shafts and steering wheel.

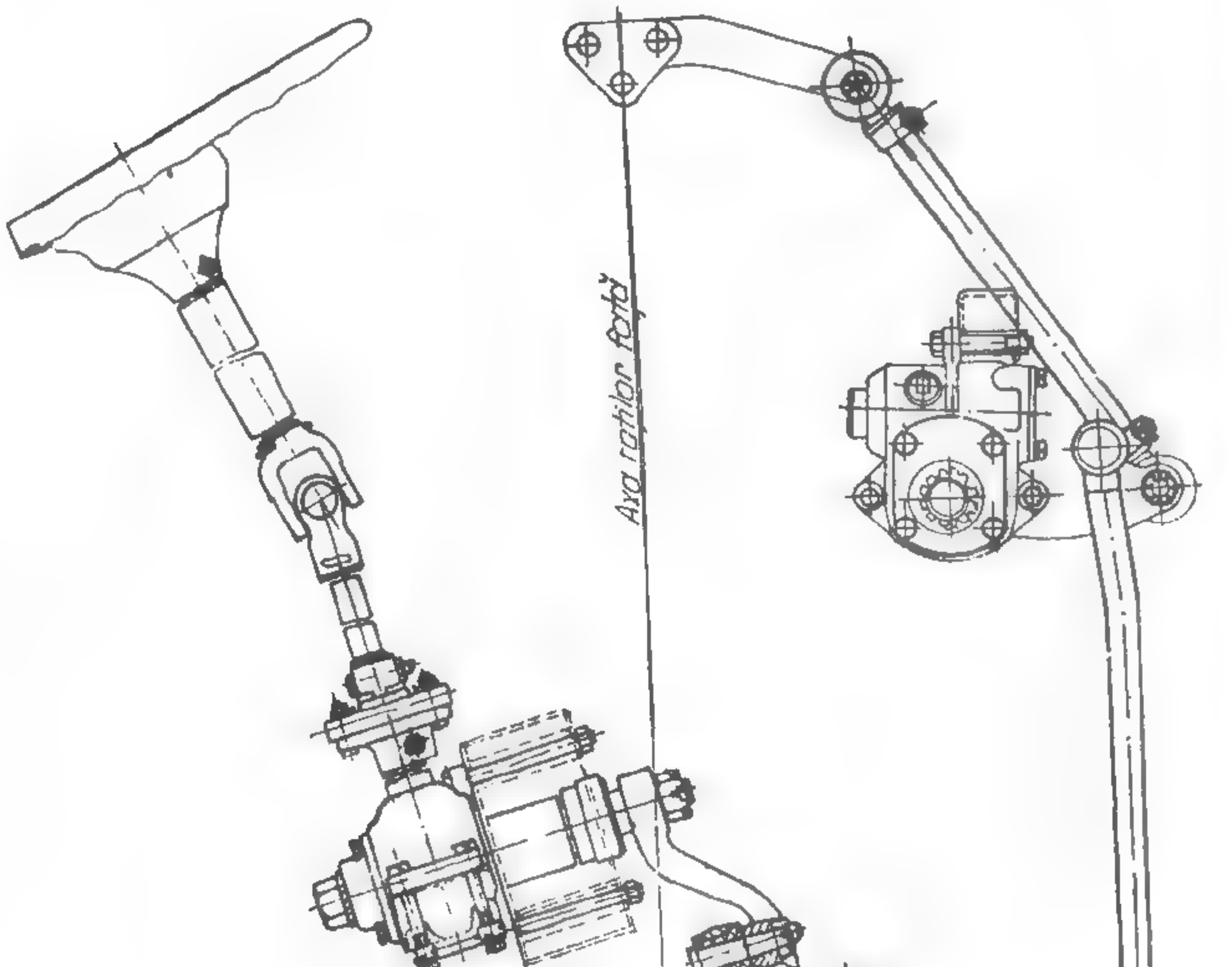


Fig. 4.1[illegible]1. STEERING LINKAGE.

The steering gear box of monoblok type is provided with a double roller (caster wheel) and an hour glass worm (see Fig. 4.142) .

The sterring wheel is of rigid type, connected with a cardanic jointed steering axle. On special require it can be fitted with a steering column lock.

The steering wheel can be left-side or right-side located, acording to the custommer's requires.

4.4.1.1. STEERING SYSTEM MAIN FEATURES

- Reduction ratio of hour glass worm/double roller assembly is

$$i = \frac{\text{steering wheel angle}}{\text{vehicle wheel angle}} = 21.5$$

- Maximal steering angle of the drop arm shaft: $\pm 35^{0}$
- Maximal angular play of steering wheel, on straight ahead running, should not exceed 18^{0} (60 mm on steering wheel rim).
- Maximal torque for turning steering wheel, when vehicle is stopped, should not exceed 6.5 m.daN (47 ft. lbs.)

GEOMETRY OF UNLOADED VEHICLE WHEELS

Ref. No.	Steering features	Rated value
1	Caster angle of the front wheels	30' $\pm$ 45'
	Difference from one wheel to the other	45'
2	Camber angle	1^{0} + 30'
	Difference from one wheel to the other	45'
3	Steering angle (inner)	30'
	Difference from one wheel to the other	1^{0} 30'

.. ..

4	Toe-in	1 - 5 mm

4.4.2. TROUBLINGS & REMEDYINGS OF THE STEERING SYSTEM

The observed troubles of the steering mechanism can be either due to the causes characteristic for steering system itself, or to some other causes, that have repercuussions on the steering system operation.

Before remedying the steering mechanism itself, eliminate firstly all the possible external causes. In the below given Table XXVIII you will find both kinds of such causes:

TABLES XXVIII

POSSIBLE TROUBLES OF STEERING SYSTEM AND THEIR REMEDYINGS

Observed trouble	Possible cause	Necessary remedyng
1. Difficult steering wheel turning in curves	Wrong tyre pressure	Check and adjust tyre pressure
	Wrong front wheels' angles	Check toe-in and the other wheels' angles
	Deformation of connecting tie rod or drop arms	Check and straighten faulty components
	Non-uniform adjusting of brakes	Check and adjust correctly the brakes
	The steering wheel axle turns with friction in its guide bush	Check clearance of the steering wheel axle in its guide bush.
	Seizing of the spider	Check cardanic joint operation.

		Lack of lubricant in the steering gear box	Check and remedy steering gear lubrication
		Wrong adjusted (too close backlash of the steering	Adjust correct backlash between roller and worm
2.	To large angular play and jerks of steering wheel	Imbalanced wheels	Balance wheels statically and dynamically
		To big a play of wheel bearings	Adjust bearing play of the front wheels
		Wear or bad adjustment of steering gear backlash	Adjust worm-roller backlash
		To big play of steering ball joints	Replace the worn components
		Axial play of steering worm in its gear box	Adjust the play and replace the worn bearings
		Worn spider or flexible coupling	Replace the worn components
		Roller axial play in the drop arm shaft	Replace drop arm shaft assy.
3.	The vehicle has tendency for turning	Non-uniform brake adjustment	Check and remedy automatic self-adjustment of brake shoes
		Decalibrated coil springs	Replace faulty springs
		Wrong tyre pressure	Check and adjust tyre pressure
		Wrong angles of front steering wheels	Adjust correctly the angles

		Front tyres with diameter differences	Use for front wheels tyres having the same rate of wear
		Too big a play of the stering front wheel bearings	Adjust play of the front wheel bearings
		Distorted connecting tie rod or drop arms	Check and replace faulty components
4.	Vibration of steering wheel	Unbalanced wheels	Balance front wheels
		Too big a play of the wheel bearings	Adjust play of the wheel bearings
		Worng tyre pressure	Check and adjust tyre pressure
		Wrong angles of steering wheels	Adjust correctly the angles
		To big a backlash of steering gear (roller worm)	Adjust backlash of steering gear
5.	Other troubles of steering system	Axial play due to wear of steering shaft spider	Replace the spider
		Blocking of steering wheel when turned out of "straight ahead" position	Marked wear of steering gear. Adjust, and if necessary replace the worn components.
		Lacks of lubricant, due to worn seals or damaged gaskets	Replace the sealing elements
		The tyres whistly on running in curves, due to worng angles of steering wheels	Adjust correctly the angles of steering wheels

4.4.3. OPERATIONS FOR REMEDYING THE STEERING SYSTEM

OP. 2.0.34.08.0 DISMANTLING GEAR BOX AND STEERING COLUMN

On dismantling the steering gear box detach its drop arm from connecting tie rod (see Fig. 4.141). Remove drop arm from its shaft using D 148 extracting device.

- Getting access from the upper side of vehicle (under engine bonnet) unscrew the two upper bolts fastening steering gear box on chassis bracket. Then from the vehicle underside remove the other two bolts of steering gear box.
- Getting access from the vehicle upper side unscrew the mounting bolt of the steering shaft flange and mark mutual position between the flange and the shaft.
- Remove by slight knoking with a hammer the stering gear box assy (together with the flexible coupling) from the steering shaft.
- For complete taking down of steering column, remove the steering column passing half-collar from the cowl, the electrical switch half-covers, the dashboard instrument plate and the column fastening collar from the cowl.

  In case the vehicle is equipped with steering column lock, mark firstly mutual position between the column and steering column lock support and unscrew locating stud screw.
- Remove from the steering column the switch block.
- Remove the steering wheel cap, unscrew the nut (M 14) and remove the steering column with the wheel by sliding it through the cowl upper side.

OP. 2.0.34.09.0 DISMANTLING STEERING PIVOT ASSY, DRAGLINKS, CONNECTING TIE ROD AND DROP ARMS

- Disconnect the driven drop arm from connecting tie rod, respectively the draglink of R.H. wheel.

Unscrew the four bolts fastening steering pivot case on chassis bracket.

- For dismantling both draglinks, undo connections of the ball joints from the two arms, while, for dismantling the connection tie rod, disconnect its ball joints from the drop arm, respectively, from the driven drop arm.

The two steering knuckle arms should be taken down from steering knuckles only if strictly neccesary, in order to not trouble the assembling of both components. In any case, if dismantled, on refitting tighten bolts wit a controlled torque of 3.3 m.daN (23.6 ft.lbs).

OP. 2.1.34.10.0 DISMANTLING STEERING GEAR

- Unscrew nut locking the adjusting screw (3) - see Fig. 4.143 - and remove the screw together with ext. tooth lock washer and the two sealing washers.
- Unscrew bolts fastening the housing side plate (1) and remove the plate together with the drop arm shaft (4) - (see Fig. 4.142).

  For releasing the drop arm shaft screw again adjusting screw (3) in the cover (1) and tighten it until the shaft gets out from the cover bearing bore (2).
- In case the cover bearing (2) is worn, i.e. the drop arm shaft has a sensible play in the bearing bore, remove the worn bearing, by means of D 149 extractor, and replace it by a new bearing.
- In case the steering roller (caster wheel) has a lateral play in the arm shaft (4) (see Fig. 4.142), or if its races are damaged or worn out (has a play against the worm even in the closest adjusted posaition), the shaft should be replaced by a new shaft assembled with double roller.
- In case the hour-glass worm has a radial play or if its races are worn out and cannot be remedied by adjustment, the worm and both radial-axial bearings should be replaced. For this:
- Unscrew bolts fastening the bottom end plate and remove the latter together with the sealing and adjusting gaskets.
- Undo split pin and unscrew the nut fastening the flexible coupling flange on the steering worm shaft (2).
- Remove the flange, together with flexible coupling, from worm shaft splined end.

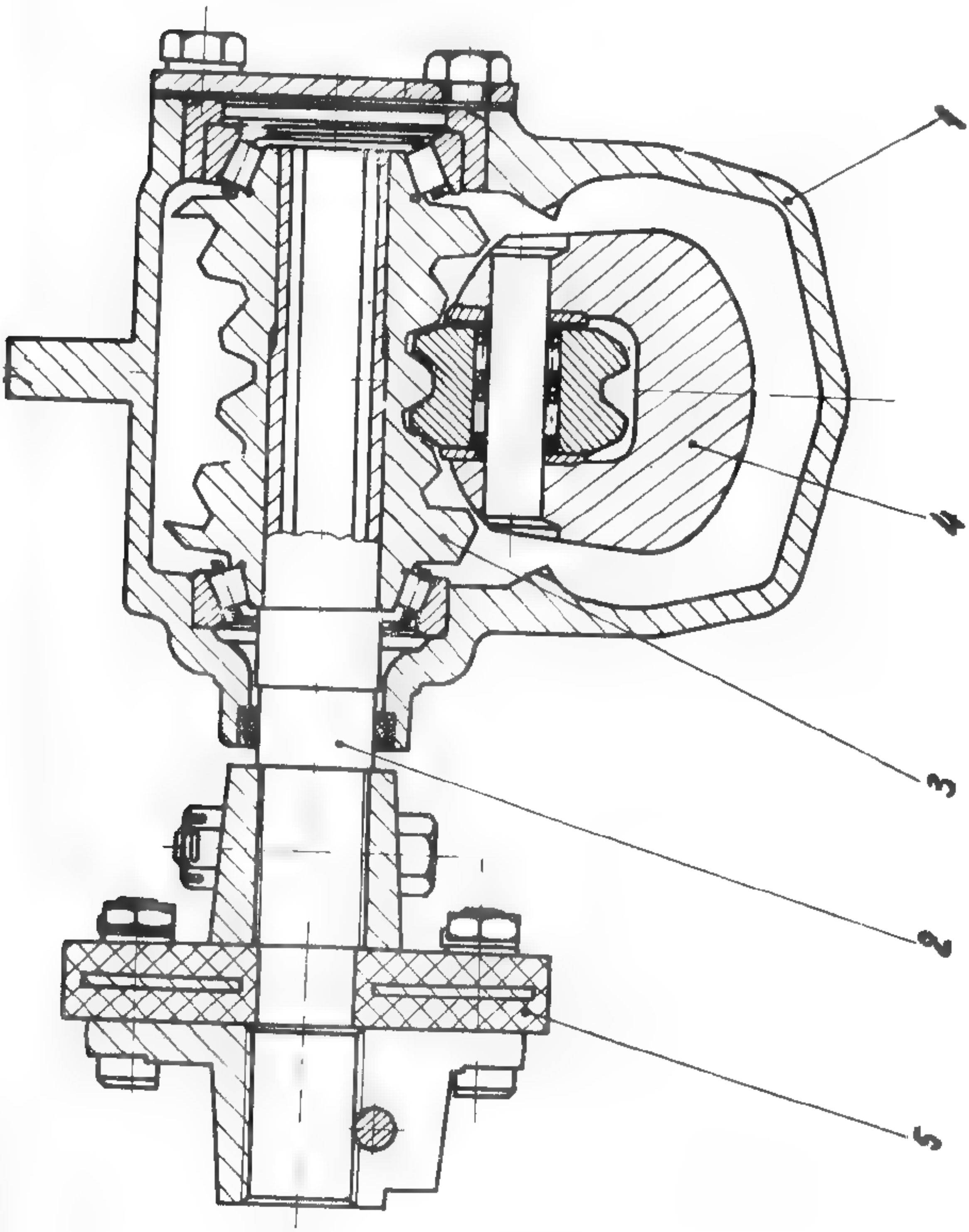


Fig. 4.142. STEERING GEAR BOX
1- Steering gear case; 2- Steering wheel shaft; 3- Steering worm; 4- Drop arm shaft ' roller; 5- Flexible coupling.

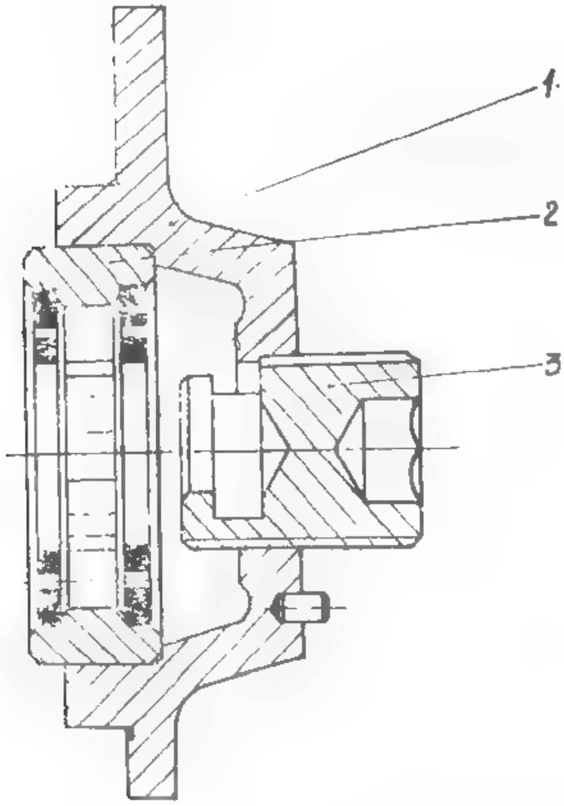


Fig. 4.143. STEERING GEAR BOX COVER WITH BEARING
1- Case cover; 2- Bearing; 3- Adjusting bolt.

- Knock slightly the shaft splined end until it gets out of the case, together with the bearing sleeve, the outer bearing and the inner bearing.
- Depress out annular oil seal.
- Check both bearing for traces of damaging or wear. If necessary, depress out the bearing outer races from the case body, respectively from the bearing sleeve.
- In case that only the worm is damaged, replace it together with its shaft.
- On refitting steering gear box use 413 AT oil (or equivalent one) and perform the above stages in reverse order, i.e.:
- Press bearing outer races into steering gear housing and in the bearing sleeve.
- Introduce into steering gear box inner taper roller cage, the worm assambled with its shaft, the outer roller cage, the bearing sleeve with the outer

bearing race pressed in it, four gaskets (two thick and two thin) and then tighten bottom end plate.

- Check bearing tightening, that sho.ld give a resistance torque of 0.06 - 0.10 m.daN (0.43 - 0.72 ft.lbs), measured by means of V 113 instrument. In case the above limits are not respected, remove or add gaskets until the resistance torque will be within above limits.
- Introduce the drop arm shaft into the steering gear box and fit the adjusting screw, up to the drop arm shaft head.
- Fit now the gasket and then the housing side plate (1); screw adjusting bolt outwards, from inside to outside, till the side plate fits over the bearing and steering gear housing and the shaft end enters the bearing bore.
- Fasten now end plate with the four bolts on the housing.
- Establish the middle meshing position, in case the worm or the drop arm shaft have been replaced and mark mutual position in keeping with the housing.
- Adjust the drop arm shaft position by means of adjusting screw (3) so that no perceptible backlash could exist for the middle meshing position. Under such condition the meshing torque, measured on the drop arm shaft end should be within the limits 0.10 - 0.25 m daN (0.72 - 1.80 ft.lbs).

For the rest, the refitting should be performed in reverse order as on dismantling.

OP. 2.1.34.11.0 DISMANTLING STEERING PIVOT ASSY

This operations should be performed only in case the annular oil seal has been damaged or when, due to some distorsions, the sterring pivot cannot be completely rotated, with a reduced, uniform friction.

- Undo and remove split pin and unscrew the nut fastening the drop arm on the steering pivot (2) - see Fig. 4.144.
- Remove drop from the steeing pivot using D 148 extractor.
- Unscrew bolts fastening the pivot case cover (4) and remove cover with its geasket.

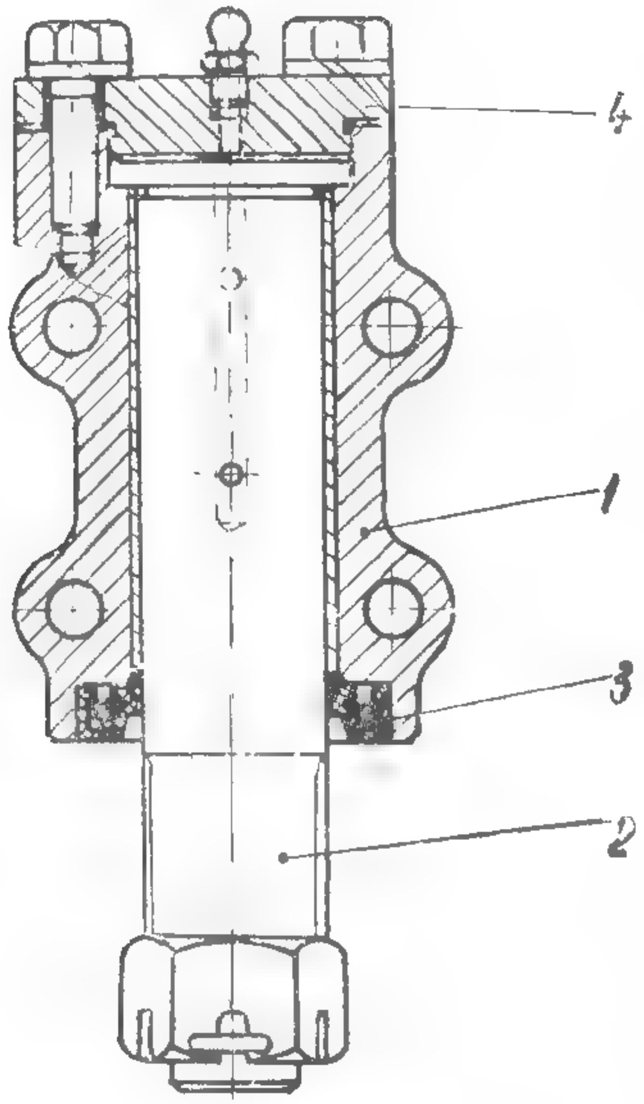


Fig. 4.144. PIVOT CASE & PIVOT ASSY
1- Pivot case; 2- Drop arm pivot; 3- Annular oil seal;
4- Gasket.

- Knock slightly the pivot end, removing it from its location. In case it is distorted or its bushing is damaged, replace the whole assembly.
- Refitt assembly in reverse order as on dismantling. On refitting smear components with UM 175 grease (or equivalent one).

OP. 2.1.34.12.0 DISMANTLING DRAGLINKS AND CONNECTING TIE ROD

In case the ball joints have perceptible play in the rod heads (3) - see Fig. 4.145 - the latter should be dismantled. For this:

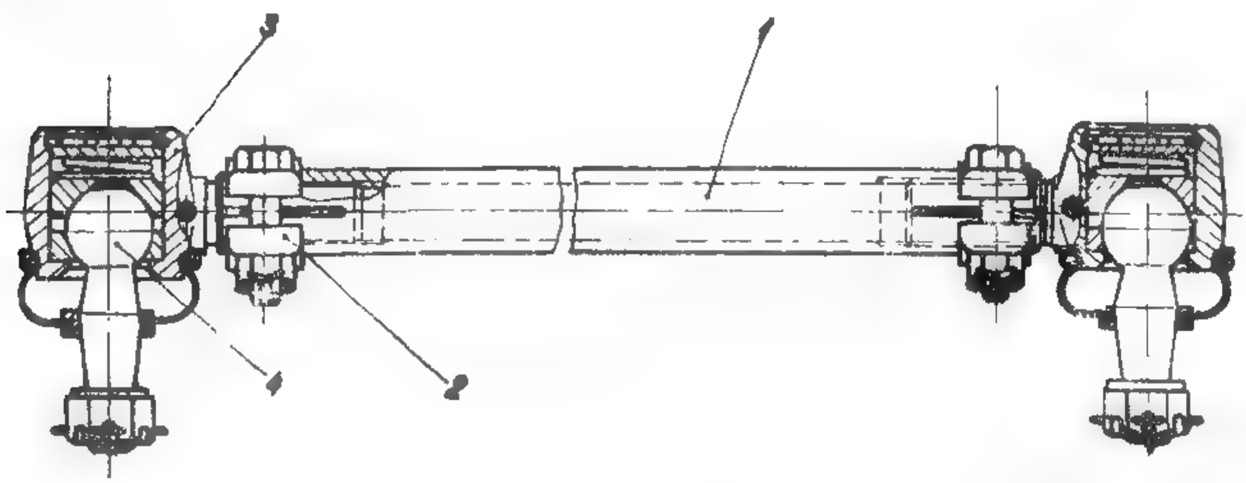


Fig. 4.145. DRAGLINK ASSY
1- Draglink ; 2- Draglink clamp; 3- Draglink head assy;
4- Ball stud.

- Remove split pins and unscrew nuts tightening draglink clamps (2).
- Remove rod head from the draglink.
- Remove dust cap from the rod head.
- Depress rod head end plate up to refuse, using a press, and remove snap ring.
- Remove the rod head from the press and take successively out: the end plate, rod head spring, ball socket and then ball stud (4).
- Check all components for wear and replace faulty parts (in case the ball stud should be replaced, replace also both inner and outer ball sockets.).
- On refitting, smear components with UM 175 grease (or equivalent one), and perform the ebove stages in reverse order.

In case the connecting tie rod of fulcrum pins are distorted (due to an accident), the damaged components should be replaced by original ones.

4.5. THE BRAKING SYSTEM OF THE ARO VEHICLES

4.5.1. DESCRIPTION OF THE VEHICLE BRAKING SYSTEM

The braking system of the ARO vehicles consists od two different systems:

- Hydraulically controlled foot (service) brake.
- Mechanically controlled hand (parking) brake.

4.5.1. A HYDRAULICALLY CONTROLLED FOOT BRAKE

The ARO vehicles have the main (service) braking system, which actuates both rear and front brakes through a common circuit. On special request the ARO vehicles can be supplied with servobrake with double circuit. The actuating of rear wheel brakes is of "simplex" type with a single cylinder) and of the front wheel brakes it is of "duplex" type (two cylinders).

The brake adjusting occurs automatically.

The type and the quantity of the brake fluid, used for ARO vehicles, are indicated in respective Operator's Handbook.

The maximal fluid pressure, which can arise in the master cylinder, is of about 90 daN/cm^2 (1280 lb/sq. inch), while in a braking system with servobrake it can reach a value of 150 daN/cm^2 (2140 lb/sq. inch).

The hydraulic braking system consists of the control elements (foot pedal, brake master cylinder), braking elements (wheel brake cylinders, brake shoes) and connecting elements (pipes, flexible feed lines, connecting fittings, T-joints) (see Fig. 4.147). The foot pedal stroke up to the toe board is of 160 mm.

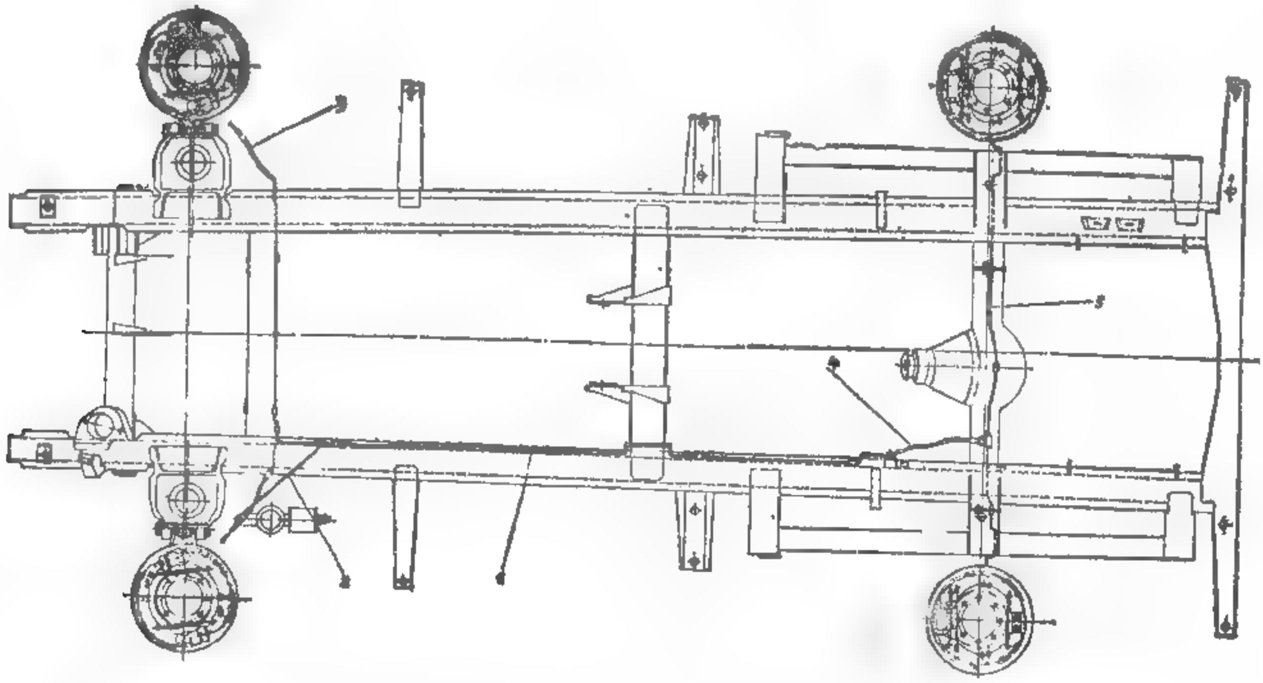


Fig. 4.147. MAIN BRAKE CONTROL HYDRAULIC SYSTEM
1- Main pipe; 2- Brake master cylinder T-pipe; 3- Front brake connection; 4- Rear brake feed pipe; 5- Rear axle brake pipe.

4.5.1. B. MECHANICALLY CONTROLLED HAND (PARKING) BRAKE

The parking brake of the ARO vehicles is of mechanical type and actuates only the rear wheels. It is normally controlled by the agency of a hand lever (1) - see Fig. 4.148 and Fig. 4.149.

The parking brake should be so adjusted that the vehicle braking, occurs when the hand lever pawl reaches the sixth tooth of the toothed quadrant.

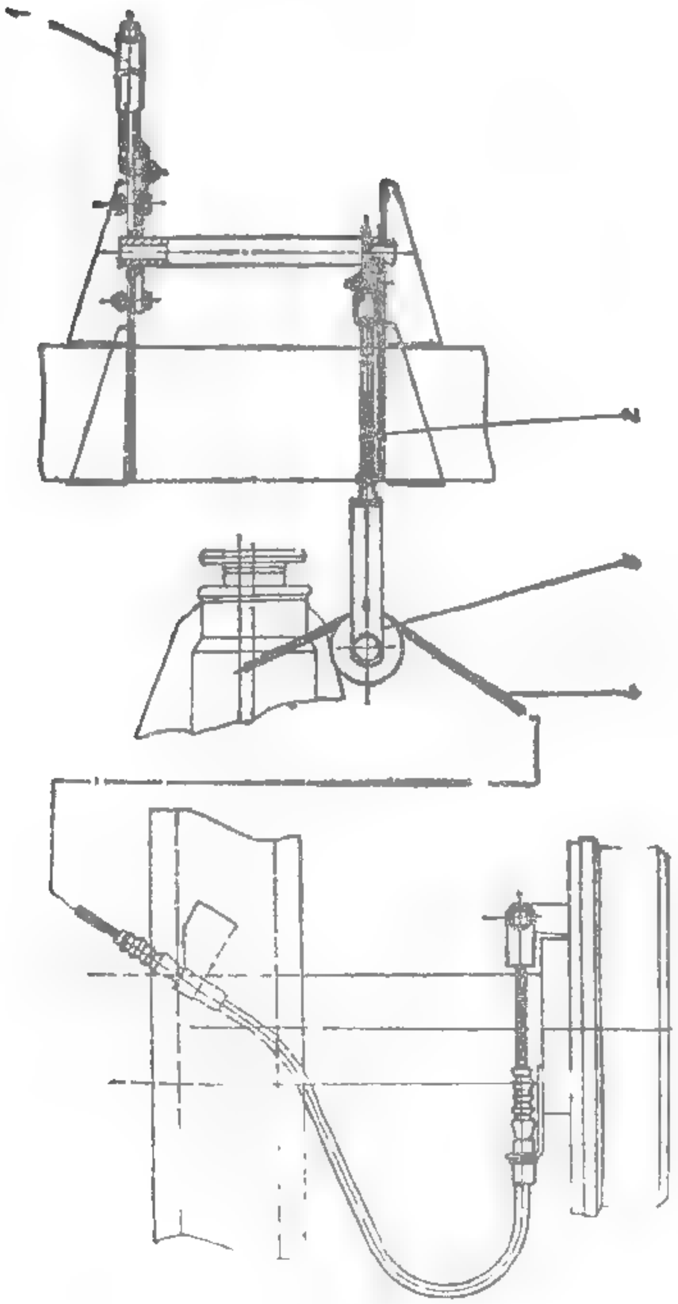


Fig. 4.148. HAND BRAKE CONTROL - TYPE I

1 - Hand brake lever; 2- Rod; 3- Brake pulley; 4- Brake cable.

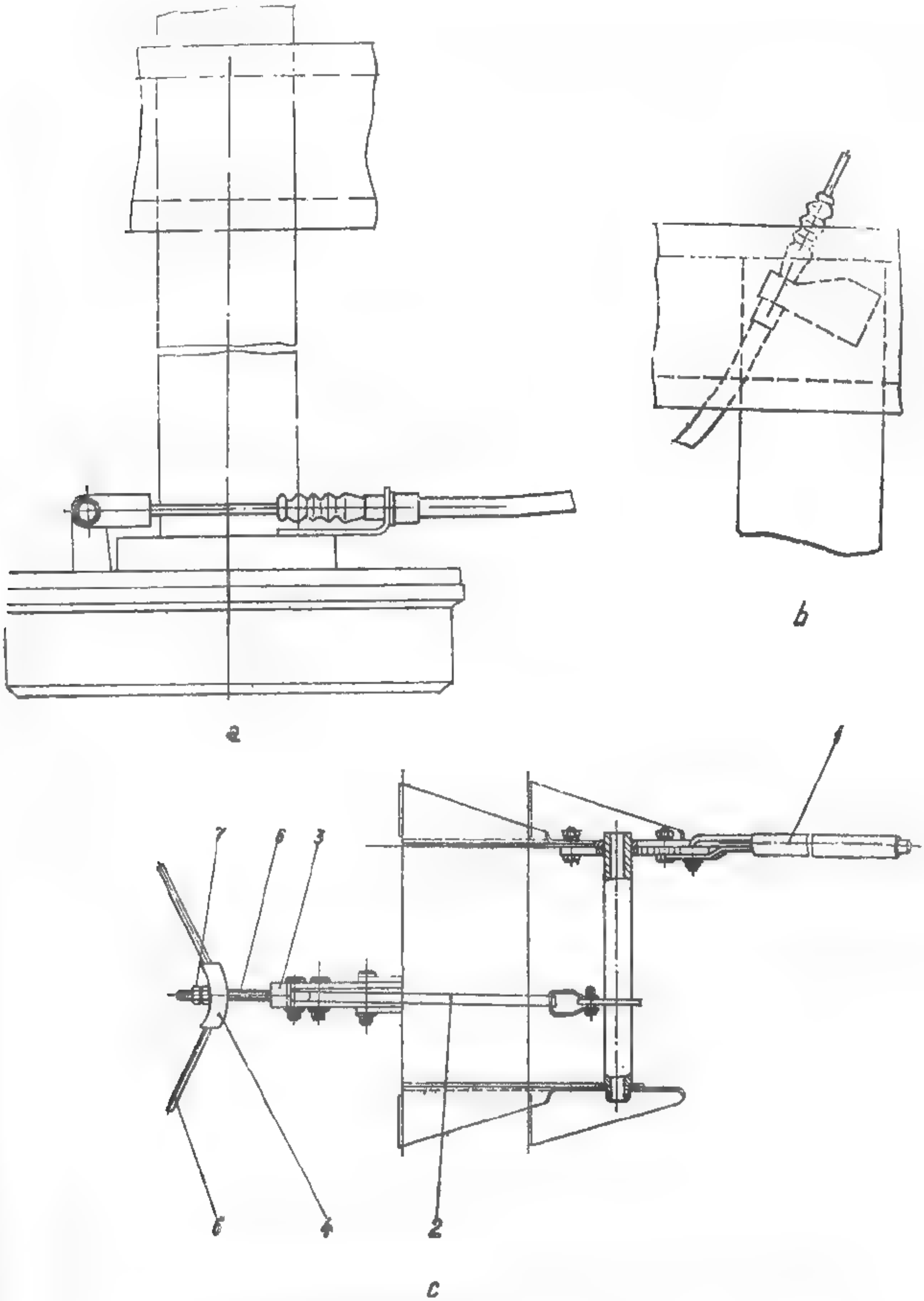


Fig. 4. 149. HAND BRAKE CONTROL - TYPE II
1- Hand brake lever; 2- Actuating rod; 3- Lever; 4- Swing bar; 5- Brake cable; 6- Adjusting rod; 7- Adjusting nut.

4.5.2. TROUBLES & REMEDYINGS OF THE BRAKING SYSTEM

4.5.2.1 TROUBLES OF THE MAIN (FOOT) BRAKE

The troubles which may occur in the main braking system are accidental troubles. These main troubles and their remedying are given below, in the Table XXIX:

TABLE XXIX

Ref. No.	Observed trouble	Possible cause	Necessary remedying
1.	When depressed down for braking the pedal reaches the toe board, without braking or has a springy return	- No brake fluid in the master cylinder	Check fluid level and top it if necesary.
		- Air presence in braking system	Bleed the braking system
		- Wheel brake cylinders are not leakproof	Check wheel brake cylinders and replace faulty piston cups
		- Brake master cylinder is not leakproof	Check master cylinder and replace, if faulty, piston cup
		- Brake circuit is not leakproof	Check the circuit and, if necessary, make it tight.
2.	Brake gets efficient only after second or third pedal depressing, altough the system has been bleeded.	Brake shoe clearance self-adjusting sys- does not operate	Remedy self-adjusting system by replacing faulty components

		Foot pedal stroke is not adjusted	Adjust correctly the pedal stroke
		Brake fluid leakages in the system	Check the whole system for leakages and remedy the trouble
3.	On braking the vehicle has tendency to bend in or te skid	Self-adjusting system of one of wheels is out of order	Check clearance of the brake shoes and remedy the trouble
		One of wheel brake cylinders is non operating (jammed piston)	Replace faulty cylinder assy.
		Respective ferrodo linings are imbibed with lubricant	Clean the linings and make them rough using fine emery paper
		Connecting pipe of respective wheel is accidentaly throttled by compressing	Replace faulty pipe
4.	The braking distance exceeds the indicated vaule	Air presence in the braking system	Bleed the braking system
		Fluid leakages in the braking system	Check system for tightness and remedy the trouble
		Flexible feed lines are damaged and cause fluid pockets	Check and replace faulty feed lines

5. The brake fluid is muddy, forms gel deposits or evapo- rates	Different brake fluids have been mixed	Renew completely the brake fluid
6. On braking the ve- hicle stopping oc- curs with trepida- [redacted]	The brake shoes have loosened ferrodo li- ..ings	Replace ferrodo lini.., by riveting them, or fit new brake shoes.

4.5.2.2. TROUBLES OF THE HAND (PARKING) BRAKE

In course of time the cable of the hand brake may get longer, due to repeated stresses, so that efficient braking does not occur at max, the sixth to- oth of the toothed quadrant. For remedying this trouble, adjust the brake cable length.

In case that the brake cable protecting rubber sleeve is damaged and let penetrate, between it and the cable corrosive agents, causing cable corrosion and its blocking, replace the sleeve and corroded cable. If cable jamming is due to penetrating of impurities between it and its protecting sheating, dismantle the cable, wash it in white-spirit and -after drying smear it with RUL S 140 grease.

4.5.3. OPERATIONS FOR REMEDYING THE BRAKING SYSTEM ELEMENTS

OP. 2.0.35.06.0 DISMANTLING BRAKE HYDRAULIC CONTROL

- Undo connection between brake & clutch control pedals and piston pushing rods.
- Remove pedal return springs, mounted between pedal upper pedal end and the spring anchor on the cowl (See Fig. 2.38).

- Drain completely braking system and remove brake & clutch lines form respective master cylinders.
- Unscrew bolts fastening master cylinder braket on cowl, removing at the same time both master cylinders from their bracket.

  On refitting, performa the above stages in reverse order.
- Adjust play of both brake & clutch pedals.
- Adjust cluth throwout bearing clearance.
- Bleed brake & clutch hydraulic control system.

OP. 2.0.35.07.0 DISMANTLING BRAKE & CLUTCH CONNECTING PIPES

- Drain completely hydraulic control system.
- Remove faulty pipes, unscrewing their connecting joints and removing pipes from under the clamps welded on chassis frame and on its middle cross member (see Fig. 4.147).
- Before fitting new pipes or refitting dismantled pipes clean them from any impurities by air blasting.
- After reconnecting all the pipes, connect the pipe end, which should normally be connected to the master cylinder, to connecting fitting of D 150 device, in order to check tightness of hydraulic brake control system.

OP. 2.0.35.08.0 DISMANTLING HAND BRAKE CONTROL CABLE

- Undo and remove split pin and the pin which assemblies the cable fork and the brake control lever of the brake anchor plate.
- The cable got free should be removed from the two brakets welded on chassis frame.
- Unscrew counternut and adjusting sleeve from the brake control rod (2) - see Fig. 4.148 - and remove the fork and brake pulley assy; now the brake cable is completely free.

Perform refitting in reverse order and adjust finally the hand brake until it gets efficient when the retaing pawl reaches the sixth tooth of toothed quadrant.

OP. 2. 0. 35. 09. 0. DISMANTLING HAND BRAKE CONTROL

- Remove the fork & brake pulley from the brake control rod.
- Remove split pin, washer and the pin which fastens control lever in the chassis bracket.
- Unscrew the three bolts which fasten the toothed quadrant on the L. H. chassis braket and by lateral shifting draw out the brake control lever shaft, taking it down.

  This operation is rather difficult, due to control lever and brackets position and it is advisible to overhaul the hand brake control on occasion of vehicle general overhauling, when the body is taken down from the chassis.

  Perform refitting in reverse order as on dismantling.

4. 6 VEHICLE FRONT AND REAR SUSPENSION

4. 6. 1 DESCRIPTION OF VEHICLE SUSPENSION

The ARO vehicle suspension system consists of two component parts, namely, front and rear suspension.

The front suspension is of independent type having unequal cross arms, provided with helical coil springs, supported by rge upper arms. The hydraulic shock absorbers are of telescopic type, being mounted inside the coil springs.

The suspension stroke is limited to both directions by rubber pads, within which interval the camber angle varies by 1^{o} 30' and the track varies by 15 mm. The front suspension, which equipes the ARO vehicles, has a more rigid spring.

The static deflection, with the vehicle loaded up to pay load, is of 140 mm.

For the front suspension, which equips the ARO 32 vehicles, the static deflection of the springs is of 122 mm.

The used lubricant for suspension joints should be U 100 grease or equivalent one.

After a vehicle running of about 50,000 km (about 30,000 miles) the springs' residual deformation should not exceed 10 mm (the spring length being of 390 ± 5 mm).

Compressed up to 289 mm the spring should develop a force of 590 ± 40 daN (1300 ± 88 lbs).

As main components of the front suspension are: the lower control arm, jointed to the chassis by the agency of a rubber bushing and to the steering knuckle by means of a ball joint; upper control arm, jointed by the agency of a rubber bushing to the steering knuckle, by means of a threaded piece (see Fig. 4. 150).

The steering kunckle position, in keeping with the chassis frame, may be changed by introducing or removing space riders; so, the camber and the caster angles may be varied. The adjustment of steering wheel angles is indicated at 2. 3. 2. 3.

The shock absorber is mounted between the upper control arm and the chassis bracket, welded on its frame.

The rear suspension is of dependent type, provided with semi-elliptical spring and hydraulic, telescopic shock absorbers. The blade springs are completed by AEON type rubber pads, which take over the rigid shocks. Between the spring blades are interposed plastic spacer pieces, being meant to reduce the friction between the spring blades.

There are two types of rear springs which equipe the ARO vehicles: for modernized roads and, to a smaller extent, cross-country roads; secondly, for hard cross-country conditions These spring types are identified in the Spare Parts list by index 3 and 2 respectively.

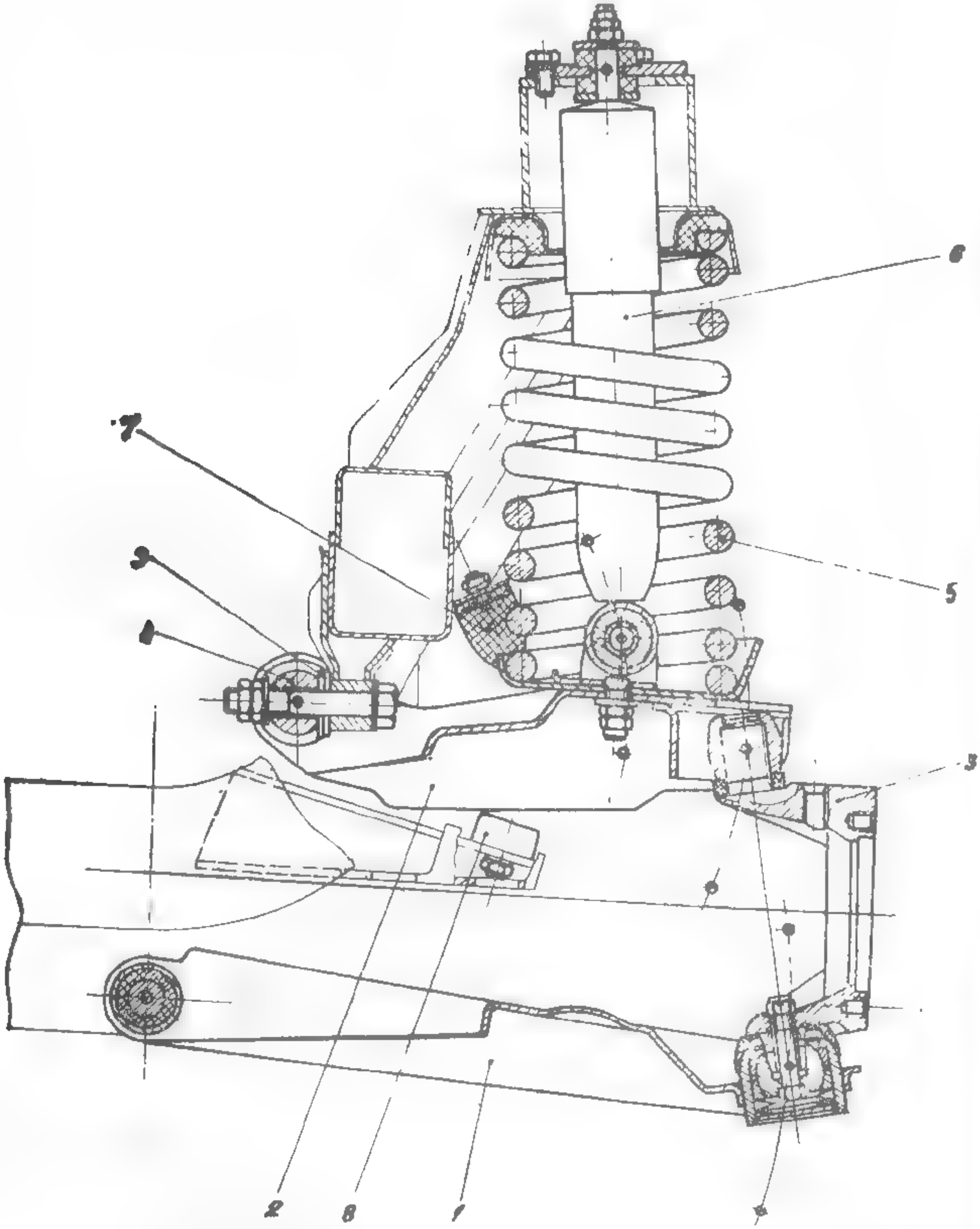


Fig. 4.150. FRONT SUSPENSION
1- Lower control arm; 2- Upper control arm; 3- Pivot bracket; 4- Upper control arm bracket; 5- Coil spring; 6- Shock absorber; 7- Upper stop bump; 8- Lower stop bump; 9- Adjusting shims.

TABLE XXX

THE BLADE CHARACTERISTICS FOR INDEX II SPRING (in mm)

Ref. No.	Part number	Blade thickness	Inner radius	Camber of the free blade	Developed length
0	1	2	3	4	5
1	240-29. 12. 001-2	6	1317	152	1280
2	240-29. 12. 002-2	6	1271	158	1280
3	240-29. 12. 003-2	6	1278	129	1160
4	240-29. 12. 004-2	6	1187	121	1080
5	240-29. 12. 005-2	6	1193	99	980
6	240-29. 12. 006-2	6	1198	80	880
7	240-29. 12. 007-2	6	1204	62. 5	780
8	240-29. 12. 008-2	7	46859	1. 5	680
9	240-29. 12. 009-2	7	16866	- 2. 5	580
10	240-29. 12. 010-2	7	- 5369	- 5. 1	480
11	240-29. 12. 011-2	8	- 3340	- 5. 2	380

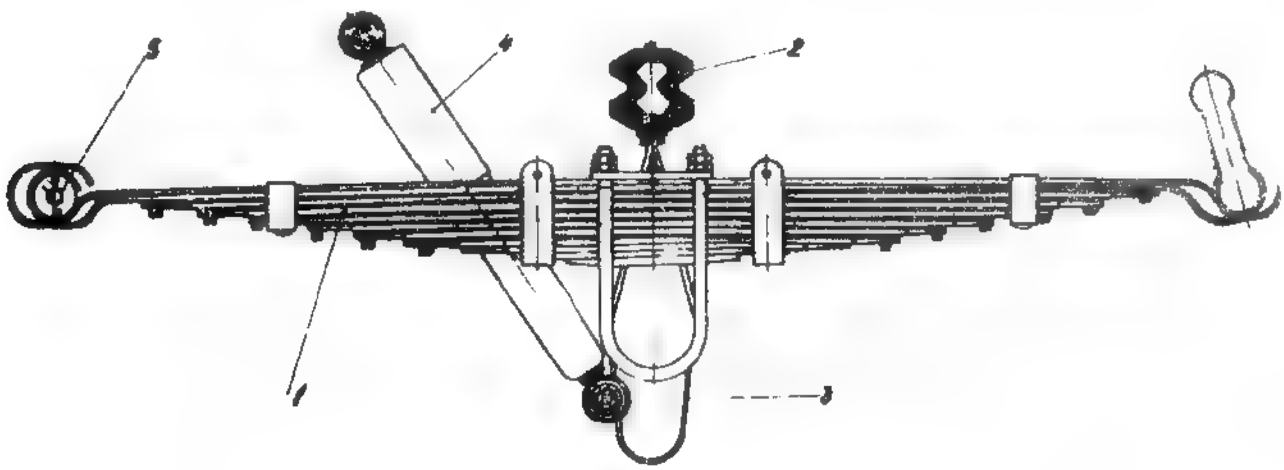


Fig. 4.151. REAR SUSPENSION
1- Rear spring assy; 2- AEON sprind pad; 3- Rebound strap; 4- Shock absorber; 5- Spring bolt.

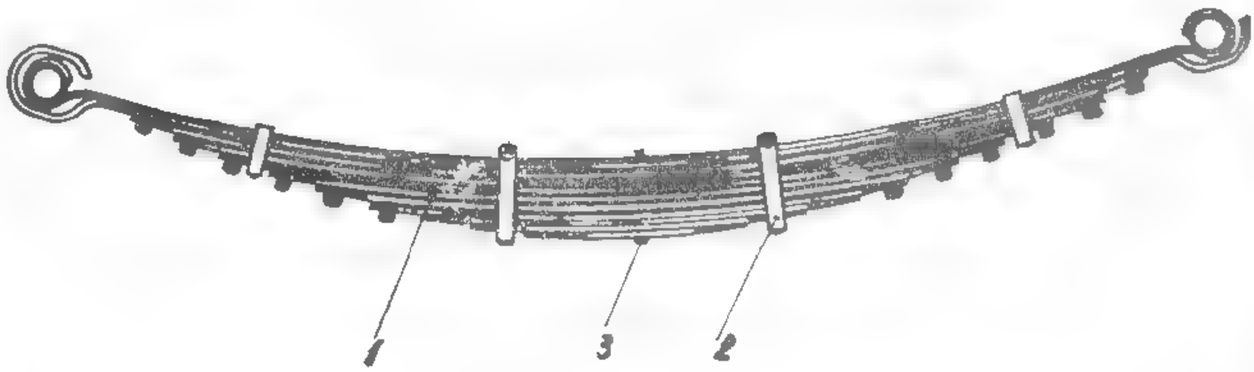


Fig. 4.152. REAR SPRING ASSY TYPE III
1- Spring blade; 2- Spring clip; 3- Centering bolt.

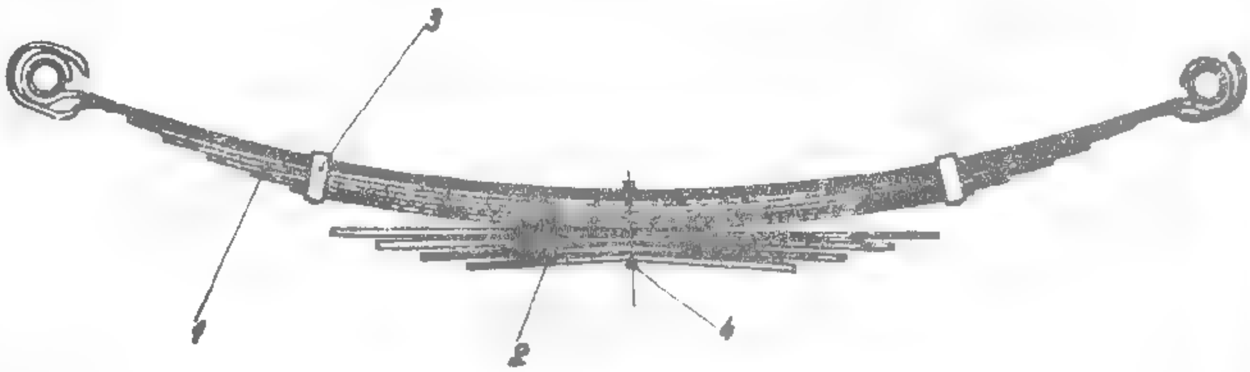


Fig. 4.153. REAR SPRING TYPE II
1- Spring blade; 2- Spring blades with negative camber; 3- Spring clip; 4- Centring bolt.

The spring blade characteristics for index 3' springs are given in the below Table XXXI (see also Fig. 4.154).

TABLE XXXI

THE BLADE CHARACTERISTICS FOR INDEX III SPRINGS (in mm.)

Ref No.	Part number	Blade thickness	Inner radius	Camber of the free blade	Developed length
1	ABi-29. 12. 001	6	1313	152. 9	1500
2	ABi-29. 12. 002	6	1320	152. 1	1480
3	ABi-29. 12. 003	6	1327	124. 7	1180
4	ABi-29. 12. 004	6	1335	107. 7	1080
5	ABi-29. 12. 005	6	1341	92. 1	1000
6	ABi-29. 12. 006	6	1151	90. 7	920
7	ABi-29. 12. 007	6	1156	75. 4	840
8	ABi-29. 12. 008	6	1161	61. 1	760
9	ABi-29. 12. 009	6	1167	49. 2	680
10	ABi-29. 12. 010	6	1172	38. 2	600
11	ABi-29. 12. 011	6	12423	2. 74	520
12	ABi-29. 12. 012	6	- 204540	- 0. 1	440
13	ABi-29. 12. 013	6	- 119991	- 1. 35	360
14	ABi-29. 12. 014	6	- 5395	- 1. 8	280

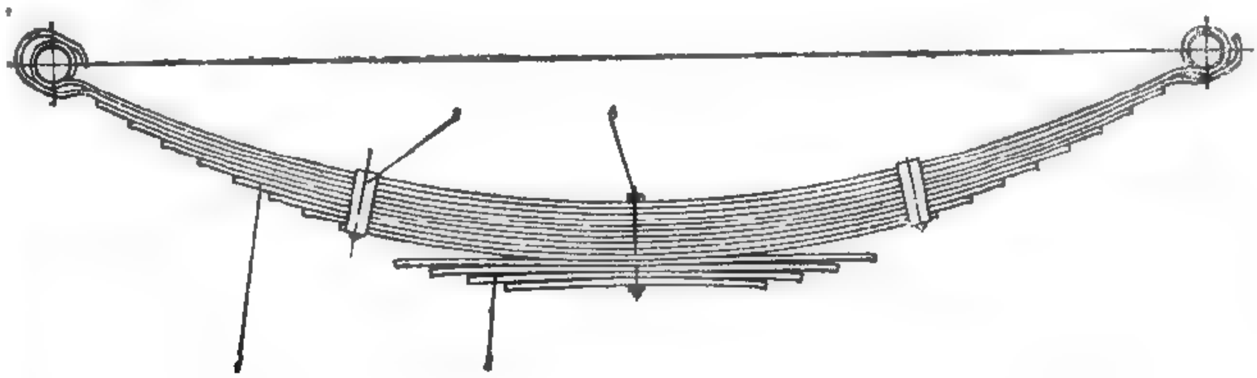


Fig. 4. 154. REAR SPRING ASSY - TYPE IV
1- Spring blade; 2- Spring blade with negative camber;
3- Spring clip; 4- Centerting bolt.

For the ARO light trucks the 3 type spring blade and the rubber pads are different (see Fig. 4.154). The extreme positions of the springs are limiteded upwards by AEON rubber pads and downwards by the limiting straps (see Fig. 4.154).

The telescopic shock absorber is of non-dismantable disign.

The nuts whith are fastening U-holts should be tightened with a torque of 7 m. daN (50 ft. lbs).

During the vehicle operation no residual deformations more than 15 mm are allowed after a running of 40,000 km. (25,000 miles).

The spring blade width is of 50 mm.

TABLE XXXII

CARACTERISTICS OF BLADE SPRINGS

Characteristic blade spring	Charesteristic parameter Type 3	Type 2	Type 1
Static camber for a load of 565 daN (1240 lbs).	165.7 mm	161.5 mm	159 ± 5 mm
Static camber for vehicle loaden condition, for upper rubber pad position	85 mm	90 mm	67 mm
Static camber for vehicle loaden position, for lower limited condition	125 mm	120 mm	140 mm

TABLE XXXIII

CHARACTERISTICS OF SPRING BLADES INDEX III (in mm.)

Ref. No.	Part number	Blade thickness	Inner radius	Camber of the free blade	Developed length
1	240-29-12.002-3	6	1770	114	1280
2	240-29.12.003-3	5	1175	120	1280
3	240-29.12.004-3	5	1130	143	1150
4	240-29.12.005-3	5	1115	118	1034
5	240-29.12.006-3	5	1060	98	918
6	240-29.12.007-3	5	1020	77	802
7	240-[illegible].12.008-3	5	1025	57	686
8	240-29.12.009-3	5	965	42	570
9	240-29.12.010-3	5	965	25	444
10	240-29.12.011-3	5	1020	13	328
11	240-29-12.012-3	5	1280	5	212

No remedyings by welding are allowed for vehicle suspension components!

4.6.2. TROUBLES OF ARO VEHICLES' SUSPENSION

The troubles of ARO vehicles suspension can be devided in front and rear suspension troubles.

TROUBLES & REMEDYINGS OF THE FRONT SUSPENSION

The troubles of the front suspension occur as a following of the wear of some components, being in relative moving or due due to some components having hidden defects.

In the below given Tables XXXIV and XXXV are given the troubles their causes and remedyings for front and rear suspension.

TABLE XXXIV

FRONT SUSPENSION TROUBLES AND THEIR REMEDYNGS

Observed trouble	Necessary remedying
The shock absorber loses fluid	Replace the faulty shock absorber
The suspension "koncks" the rubber pads, due to the following causes:	
- Faulty shock absorber which does not damp the oscilations	Replace faulty shock absorber
- The suspension coil spring are weak (decalibrated).	Check spring characteristics and if wrong, replace the springs.
- The spring (or springs) is broken	Replace broken springs.
Noises and excessive plays in the vehicle steering, due to worn rubber bushings of steering control arms.	Replace damaged or worn out rubber bushings.
Abnormal play and noise in the steering knuckle joint with the lower control arm, due to wear of respective ball joint or of ball socket, or to decalibrated spring washers.	Replace faulty components. Replace decalibrated spring washers.
Distorted control arms, due to a shock.	The control arms are made of low-carbon steek shoet and can be hot straightened. Finaly, adjust again the steering wheel angles.

TABLE XXXV

REAR SUSPENSION TROUBLES AND THEIR REMEDYINGS

Observed trouble	Necessary remedying
Rear suspension does not absorb oscillations and shocks, due to damaged shock absorbers or weak or broken spring blades.	Replace faulty components.
Excessive play in spring joints, causing abnormal noise.	Replace worn out bushings and respective bolts.
The vehicle has the tendency to deviate laterally due to following causes:	
- Broken or loosened springs	Replace the faulty springs.
- Loosened spring clips	Tighten the clips.
- Broken blade assembling bolts	Replace faulty bolts.
- Damaged shock absorbers or having no fluid in them	Replace the faulty shock absorber.
- Abnormal wear of spring rubber pads due to decalibrated or broken springs, as well as to displaced axle.	Replace damaged rubber pads and fasten correctly the springs on the rear axle, tightening then the U-bolts.
- The rear springs have damaged plastic distance plates	Fit between the spring blades new plastic distance plates.
The rear suspesion squeks	Lubricate blades having no plastic distance pellets.
Rear wheel traces are not in line with those of the front wheels.	Loosened rear spring U-bolts, i.e, displaced rear axle. Fit rear axle correctly and fasten well the U-bolts
Damaged AEON spring.	Replace faulty component.

4.6.3. OPERATIONS FOR REMEDYING FRONT & REAR SUSPENSION

OP. 2.0.29.05.0 TAKING DOWN AND REPLACING THE SHOCK ABSORBER

In case that noises are heard in the shock absorebrs, there are observed un-amortized oscilaitions or fluid leakages, it should be performing of chacking and replacing of the faulty shock absorbers.

REMEMBER TAHT: The shock absorder is of enclosed non-dismantable type so that they are to be replaced in case if being faulty.

This operation will be better performed when the vehicle is lifted on an inspection ramp.

- Slacken counter-nut and nut which fasten the shock absorber to the front suspension upper control arm. Operation gets accesible form underside of vehicle.
- Coming from upper side, below the engine bonnet, unscrew the 3 bolts, fastening on chassis bracket also the shock absorber plate.
- Remove shock absorber form the vehicle upper side.
- Remove from the shock absorber its plate and the lower bracket.
- Check shock absorber, according to the chapter concering the suspension repairs.

On refitting, performe the above stages in reverse order.

OP. 2.0.29.06.0 TAKING DOWN & REPLACING FRONT COIL SPRINGS

- Lift the vehicle on a jack and take down respective wheel. The jack should be placed under the chassis cross-member.
- Take down brake drum, cross propeller shaft, brake anchor plate and outer flange, according to indications given in the chapter concerning the front axle.

- Take shock absorber down, acc. to Op. 2. 0. 29. 05. 0.
- Introduce D 133 compressing device instead of the shock absorber and compress the coil spring until the distance between its coils will be of about 6 - 7 mm.
- Getting access from the upper side, unscrew the counter-nuts of the bolts fastening the upper control arm bracke on the chassis.

  Remember exact position of the spacer riders stacks, so as on refitting the components on the vehicle the same values of the steering wheel angles will be obtained.
- Remove bolts fastening the lower control arm to the chassis crossmember.
- Remove both control arms, assembled with the steering knuckle.
- Gradually elease the compressed spring and when completely free, remove it from the D 133 compressing device and put it away.

  If the removed spring is decalibrated (due to overstrains), it should be replaced by a new spring.

  On refitting perform the above operations in reverse order, but respecting the following remarks:

  a) The new spring should be the same condition group as that of the other front wheel.

  b) Its mounting position should be so that beginning of the upper first coil (touching the upper control arm) should be towards the vehicle longitudinal axis.

  c) The spring releasing from the compressing device should be made only after refitting both control arms on the chassis, carefully observing the right setting of the spring in the control arm plate (see Fig. 4. 150).
- Finally, tighten nuts, fastening the upper control bracket, with a torque of 10 m. daN (72. 3 ft. lbs) and respective counter-nuts with 7 m-daN (50 ft.lbs.).

OP. 2. 0. 29. 07. 0 TAKING STEERING KNUCKLE DOWN

- Lift the vehicle on a jack and take down respective wheel.
- Take down the brake drum cross propeller shaft, brake anchor plate and

outer flange, according to indications given in the chapter concerning the front axle.

- By means of special D 134 compressing device compress the spring washers below the ball joint; then, using the Segers pliers, remove the snap ring from below the spring washers.

  REMARK: The position for this operation is rather uncomfortable, so that we recommend to performe the operation after having lifted the vehicle on an inspection ramp.

- Release the D 134 compressing device and the three spring washers.
- Undo and remove the split pin of the bolt fastening the ball joint and, using special S 131 wrench, unscrew respective nut and remove the bolt.
- Slightly knock the lower control arm end, holding the latter by hand so as to retain the lower ball socket and the ball joint, which are so released from the steering knucle taper pivot.
- Remove dust cover from the ball joint.
- Remove the side bushing of the upper control arm (6) - see Fig. 4.155 making so free the pivot body (5), that is to be removed together with the steering knuckle support (3).
- Unscrew pivot body (5) from off the steering knuckle support (3) and remove it, together with rubber ring.

  On refitting perform the above stages, but respecting the following remarks:

  a) Screw the pivot body on the steering knuckle support, up to the threaded pivot, so that the steering knuckle support could still oscillate by $\pm 60^{\circ}$ as against the pivot body. Set it so that the arrow marked on the cover will be directed towards the vehicle running direction (one thread turn max. is to be free).

  b) Tighten bolt fastening the ball joint to steering knuckle support with a torque of 4.3 m-daN (31 ft.lbs) and secure the nut with a new split pin.

- The threaded lateral bushings, which fasten the pivot body, should be screwed so that pivot body centre should be at equal distance from both bushings, a tolerance of + 1.25 mm.

  REMARK: Respect the mutual position of the components before dismantling ! otherwise, a new steering angles' adjustment will be necessary (see Fig. 4.155).

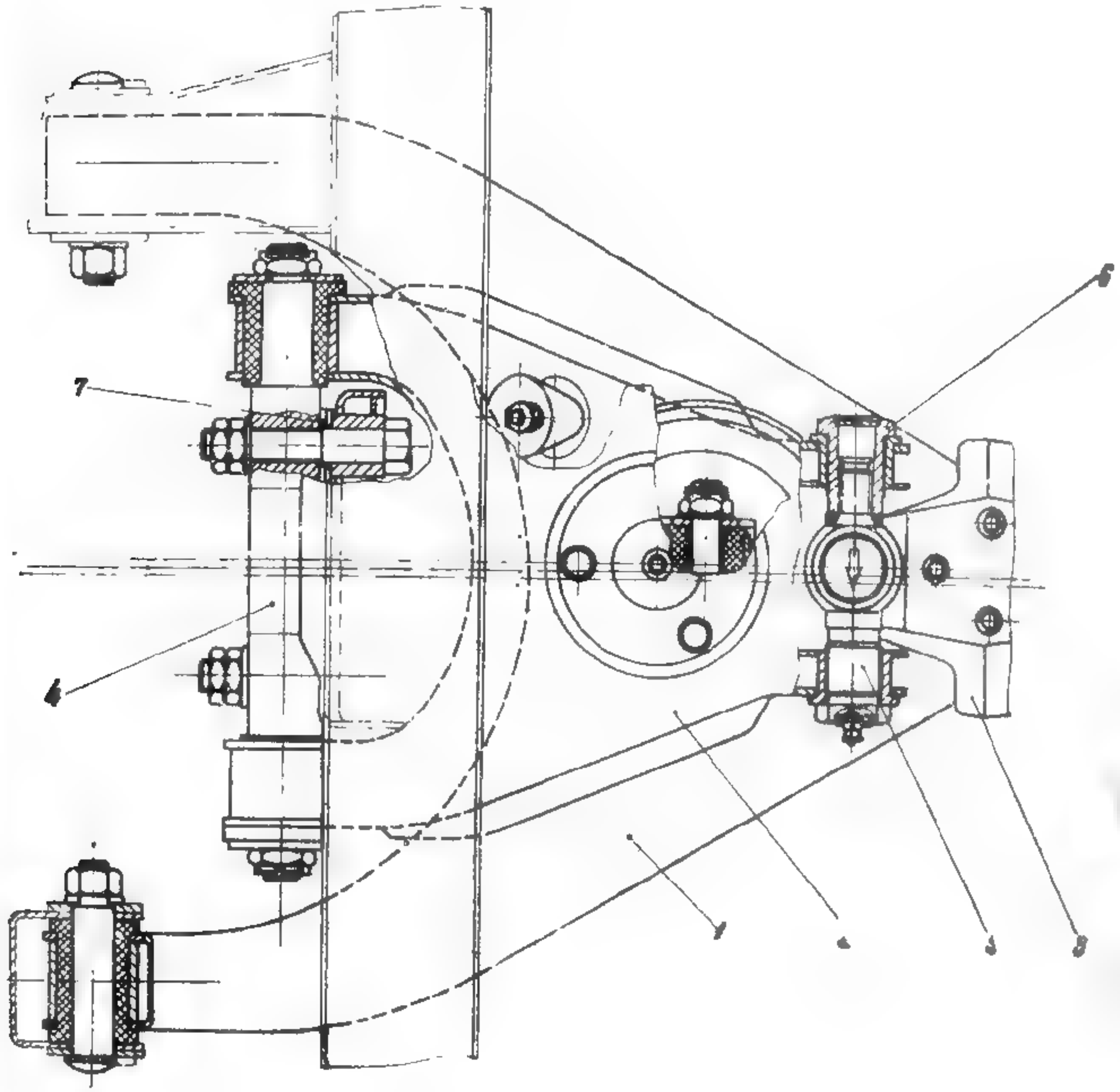


Fig. 4.155. FRONT SUSPENSION ASSY - CONTROL ARMS & STEERING KNUCKLE ASSY

1- Lower control arm; 2- Upper control arm; 3- Steering knuckle; 4- Upper control arm fulcrum pin; 5- Steering knuckle pivot; 6 Threaded bushings; 7- Adjusting shims.

- Tighten the lateral bushungs with a torque of 12 m.daN (87 ft.lbs).
- In case that a component of this assembly should be replaced by a new one, after reffiting it will be necessary to adjust the steering angles, according to indications given in the chapter concerning the adjusting of stering angles.

taking care that the thickness of the spacer rider stacks does not exceed 15 mm and the difference between the front and rear stack should not exceed 1.5 mm.

- Finally, lubricate the assembly using U 100 grease or equivalent one.

OP. 2.0.29.08.0 COMPLETE DISMANTLING OF THE FRONT SUSPENSION

In case of performing serial overhaulings of the ARO vehicles, when the mud guards are also taken down, it is recommended more complexe special tools and devices, which will make operations easier. For complete dismantling of the front suspension, proceed as follows:

- Lift the vehicle on a jack, placed under chassis frame rail or its cross member.
- Take down respective wheel.
- Take down shock absorber, acc. to Op. 2.0.29.05.0
- Compress the coil spring, using D 135 compressing device and introduce the spring on the place of the shock absorber.
- Take down the control arm assembly, the brake drum and the cross propeller shaft.
- Now, release the spring and let it free until refitting the assy.
- Fasten the taken down assembly in the D 135 mounting device and disassembly successively brake drum, cross-propeller shaft, brake anchor plate and the outer flange, according to indications given in the chapter concerning the front axle.
- Unscrew threaded lateral bushings from the upper control arm and remove them.
- The dismantling of upper control arm fulcrum pin should be carried out by means of D 136 mounting device, which ensures on reassembling a correct relative position between the control arm and the fulcrum pin, as regards the rubber bushing torsional tensioning.
- The lower control arm, assembled with the steering knuckle support, will be set in the D 137 mounting device. Using the lever, with which the device is provided depress the plate below the ball joit and remove the Segers snap ring.

- Going on, perform the rest of dismantling acc. to Op. 2.0.29.07.0
- Check dismantled ball joint for seizing traces (both ball socket and the ball itself), and if necessary, replace the damaged components.

  REMARK: The upper ball socket should be removed by slight knocks, using the S 132 mounting mandrel.

  On refitting the front suspension perform the above operations in reverse order, taking in account the remarks mentioned in the Op. 2.0.29.07.0 describing.

  Tighten the nuts of upper control arm fulcrum pin until the two washers will be pressed on the pin shoulders. Then tighten also the two counter-nuts, securing them with new split pins.

  The relative position of the components is shown in the Fig. 4.150.

OP. 2.0.29.09.0 DISMANTLING OF THE REAR SPRING

- Lift the vehicle on a jack, set near respective spring, untill the wheel rises above the ground.
- Set a support under rear axle, in order to make refitting easier.
- Getting acces from the vehicle under side (operation is still easier when performed on an inspection ramp), unscrew counter-nuts of the U-bolts, fastening rear axle to the springs. Unscrew also respecive nuts.

  Remove U-bolts and spring clamping plates (see Fig. 5.151).
- Unscrew the nut of the spring front fastening bolt and then, using D 146 extractor, remove the bolt together with respective washer.

  Unscrew the two nuts of the spring rear shackle and by slight knocking, remove shackle.
- Now, remove assembled spring.

  On refitting rear spring perform the above operations in reverse order.

OP. 2.0.29.10.0 DISMANTLING THE REAR SPRING ASSY

In case some troubles have been found in the rear spring operation, which requires the replacing of some blades (as a result of spring characteristic meansurement), dismantle the spring as follows·

- In case of the spring type 3, unscrew the middle bolt (3) - see Fig. 4.152 - and then the bolts of the two spring clips (2), getting free the blades 6 - 11.
- In case the blade 10 is faulty, remove the two spring clips, riveted on the blade, by drilling both rivets. The removed clips should be riveted on the new spring blade.
- In case the troubles have occured on the blades 1 - 5, remove firstly the rubber bushings from off both spring ends.
- Then, using a chisel, undo slightly the marginal clips, as much as to be able to remove the spring blades. If fissures will occur on the clips, the latter should be replaced with new ones. In case that just the blade 5 should be replaced, on which the two clips are riveted, remove the clips by drilling the rivets and rivet them on the new blade 5.
- Bend the edges of the spring clips over the blade 1 after having tighten the blades' stack.
- On refitting the spring assy smear with graphite grease the blades having no plastic distance plates between them. The lacking or broken distance plates should be replaced by new ones.

Perform spring refitting in reverse order as on dismantling.

In case of the rear spring type 2, having no central clips (see Fig. 4.153), on its dismantling will be performed the above operations, excepting the removing of central clips.

As far as in this case the spring type 2 has no plastic distance plates on reassembling all 11 blades should be smeared with graphite grease (only on the faces contacting between them).

In case of the rear springs type 4 the clips are not fastened with bolts and on dismantling the spring they should be slightly undone, in order to allow removing of blades. Having 14 blades, without plastic distance plates, all the blades should by smeared with graphite grease, on their faces contacting between them.

OP. 2.0.29.11.0 TAKING DOWN THE BEAR SHOCK ABSORBER

- Lift vehicle on a jack, placed this time under the rear axle housing.
- Take down respective wheel.
- Undo and remove the split pins, securing the nuts of the bolts which fasten the shock absorber to the chassis and to the rear axle.
- Remove the two bolts by slight axial knocks.
- Remove faulty shock absorber and fit on its place the new one.

REMARK - Before fitting the new shock absorber, extend it and then compress it up to the mounting size, checking it for possible faults, due to faulty storage (knocks, working surface oxidation, etc.).

OP. 2.0.29.12.0 TAKING DOWN AEON SPRING PAD

- Lift the vehicle on a jack, placed under the chassis frame and take down the wheel.
- Retaining the bolt (3) - see Fig. 4.156 -, through pad inside, unscrew the nut fastening the pad on the rear spring.

Refit the pad in reverse order.

OP. 2.0.29.13.0 REFITTING OF REAR SUSPENSION

- Refitt rear suspension, performing in reverse order the Op. 2.0.29.09.0, Op. 2.0.29.0 and 2.0.29.12.0.

On refitting pay special attention to fastening the springs on the chassis frame and to fastening the rear axle to the springs, by the agency of the U-bolts The nuts of the U-bolts shoud be tightened with a torque of 7 m. daN (51 ft.lbs). The nuts of the bolts, fastening the springs to chassis frame, should be tightened with a torque of 5.5 $\pm$ 1 m.daN (40 ft.lbs $\pm$ 7,2).

- In case the rebound straps (3) - see Fig. 4.151 - have traces of wear, they should be replaced.

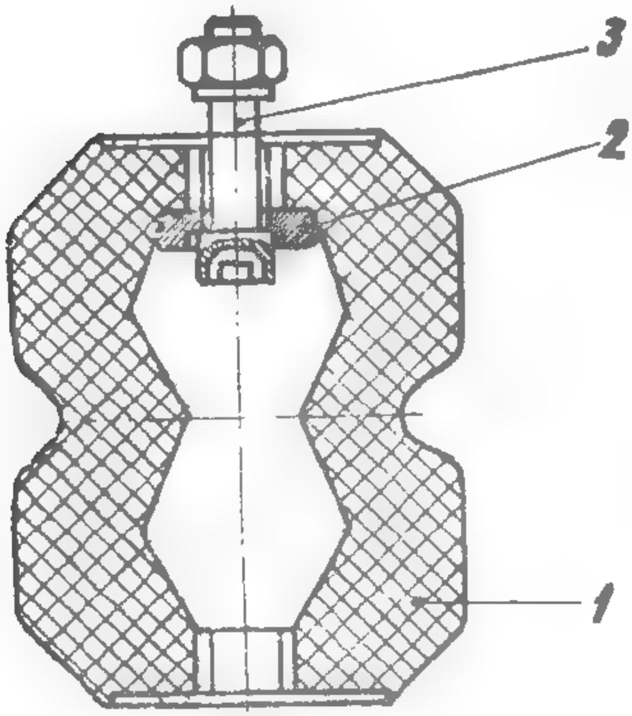


Fig. 4.156. AEON SPRING RUBBER PAD
1- AEON pad; 2- Connecting piece (disc); 3- Fastening bolt.

4.7. THE VEHICLE CHASSIS FRAME

4.7.1. DESCRIPTION OF THE CHASSIS FRAME

The chassis frame of ARO vehicles is a rigid, welded consreuction, made up of two frame rails, of closed case type, and three cross-membres (front, middle and rear member).

On the chassis frame are welded all the brackets, meant for fastening of different units of the vehicle (engine, body, suspendion, etc.). In order to better identify the chassis components, see Fig. 4.157.

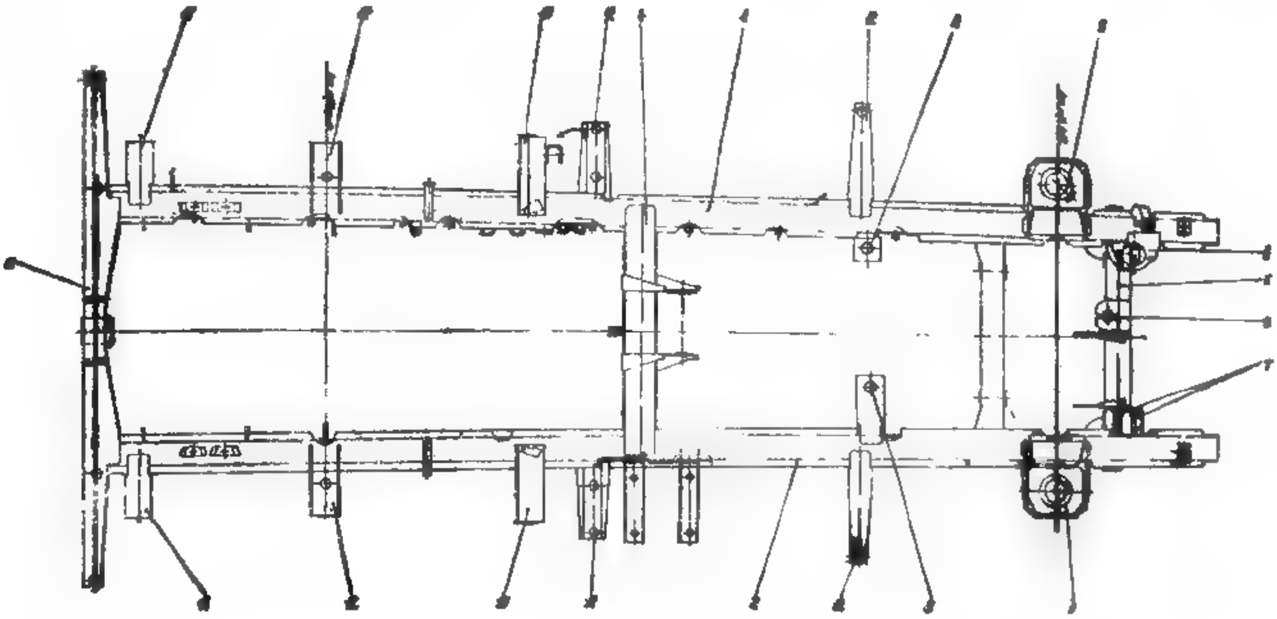


Fig. 4.157. CHASSIS FRAME ASSY
1- L.H. chassis rail ; 2- R H. chassis rail; 3- Rear cross member; 4- Middle cross member; 5- Front cross member; 6- Steering box bracket; 7- Steering pivot bracket; 8- Engine brackets; 9- Front spring bracket; 10- Rear spring front bracket; 11- Rear spring rear bracket; 12- Body fastening brackets.

4.7.2. THE CHASSIS FRAME FAULTS AND THEIR REMEDYINGS

The faults which my occur on chassis frame result from vehicle collisions or to irrational operation for a long time, on very rough grounds These faults may be:

- Chassis frame distortions
- Detachings of some welded brackets
- Fissuring of different chassis elements.

The remedying of these faults should be carried out only in specialized workshops, performing strength weldings and respecting the rated sizes of the chassis frame.

4.7.3. OPERATIONS FOR REMEDYING THE FAULTY CHASSIS FRAME

OP. 2.1.50.01.0 TAKING BODY DOWN FROM THE VEHICLE

Bring the vehicle into a workshop.

- Take down, successively, the body, the steering system, the supply system, the brake cluth hydraulic control system, the hand brake control and finally, the front and rear bumpers.
- Lift the chassis on a support and take down the wheels, front axle, front suspension, rear axle and rear suspension.

On refitting the operations should be performed in reverse order.

On dismantling, as well as on refitting, should be used special devices, indicated in the operations concerning the taking down and refitting of different vehicle units.

4.8. VEHICLE BUMPERS' SYSTEM

4.8.1. DESCRIPTION OF THE VEHICLE BUMPERS

The bumpers are meant to ensure the vehicle protection against the shocks and collisions. The vehicle is provided with a front bumper and two rear bumpers.

The bumpers are fastened to the vehicle chassis frame with bolts.

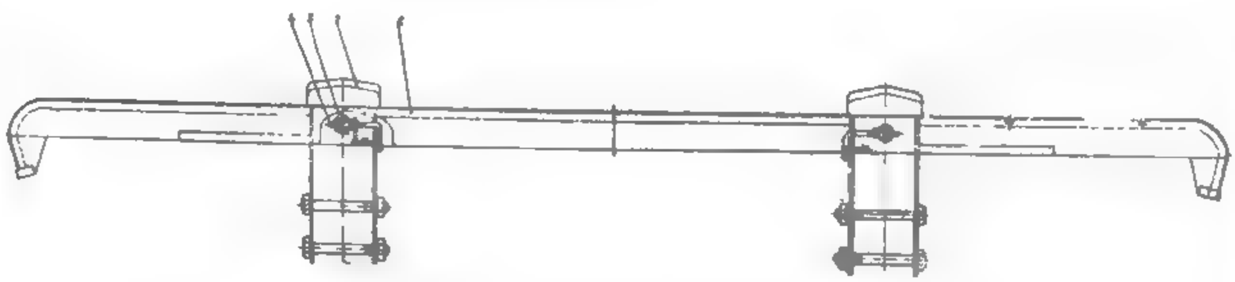


Fig. 4.158. FRONT BUMPER ASSY
1- Front bumper assy; 2- Rubber buffer; 3- Tow pin; 4- Locking rod.

4. 8. 2. FAULTS OF THE BUMPERS AND THEIR REMEDYING

The faults which may occur on the bumpers result from collisions. These faults can be: distorsions, fissurings, etc. Their remedyng is performed by replacing faulty bumper, while in slight cases it can be done by applying knocks for straightening the bumper.

4. 8. 3. OPERATIONS TO BE PERFORMED FOR REMEDYING OF BUMPERS

OP. 2. 0. 27. 01. 0 TAKING DOWN FRONT BUMPER

- Lift the vehicle on an inspection ramp and unscrew successively the four nuts of the bolts, fastening the bumper to the chassis rails.
- Remove the bolts and then the bunper.

OP. 2. 0. 27. 02. 0 REMOVING RUBBER BUFFER AND THE TOW PIN

- Lift the vehicle on an inspecting ramp and unscrew the two M 8 nuts, behind the buffer clamping plate (see Fig. 4. 158).
- Remove the clamping plate and draw the buffer forwards.
- Depress lock of the tow pin and remove the pin upwards.
- On refitting, performe the above stages in reverse order.

OP. 2. 0. 27. 03. 0 TAKING DOW REAR BUMPER (see Fig. 4. 159)

- Lift the vehicle on en inspecting ramp.
- Remove the bumper by unscrewing bolts fastening it to chassis rear cross-member.

Remove from the rear bumper reflex bracket and the rexlex reflector itself: when necessary remove also number plate lamp bracket or only number plate.

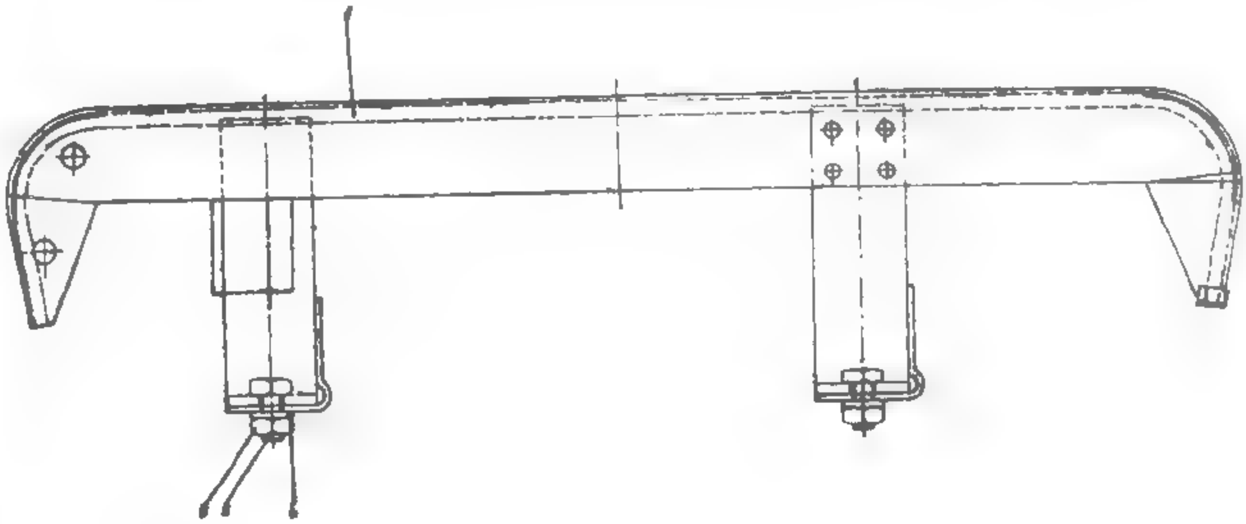


Fig. 4.159 REAR BUMPER ASSY
1- Rear bumper assy; 2- Fastening bolts; 3- Nuts;
4- Washers.

4.9. WHEEL AND TYRE ASSEMBLY

4.9.1. DESCRIPTION OF THE WHEEL AND TYRE ASSEMBLY

The wheels which equip the ARO vehicles consist of the wheel itself (wheel disc assembled with rim by welding), wheel inner tube and wheel tyre.

The ARO vehicles may be equipped whith standard wheels (tyres size 6.5 x 16) or increased wheels (tyre size 7.40 x 16).

For standard wheels the tyres may have normal sculpture or special sculpture, designed for marshy lands.

During vehicle operation the tyre air pressure should be adjusted according to the below indicated values (Table XXXVI):

TABLE XXXVI

ARO VEHICLE MODEL	Front wheel air pressure (bars	Rear wheel air pressure (bars)
ARO 240	2	3
ARO 241	2	2.75
ARO 242	2	3.25
ARO 243	2	3.00
ARO 244	2	2.75
ARO 320	2	4.25

The wheels, assembled with tyres at rated pressure, should be balanced, up to max. dynamic imbalance of 50 ± 15 gr, by mounting on the wheel rim periphery balancing weights.

4.9.2. FAULTS OF WHEEL ASSEMBLY AND THEIR REMEDYING

The faults which may occur on the wheel are spontaneous troubles, due to external causes. They are indicated in the below given Table XXXVII.

TABLE XXXVII

Ref. No.	Observed trouble	Possible cause	Necessary remedying
1	Trepidations and vehicle instability during running	The wheel are unbalanced	Balance the wheels
2	Steering instability	Unequal air pressurre in the R.H. L.H. wheel tyres	Check and adjust rught air pressure. Check and remedy the wheel wobbling, which should be

		less than 5 mm, measured on the wheel mounted on vehicle, on the middle wheel diameter.
	Too large a play of the hub bearings	Check and adjust bearing play
3 **Wheel blocking**	Exccessive bearing tightening in the wheel hub	Check and adjust right play of the wheel bearings.
	Lack of lubricant the hub bearings	Lubricate the bearings.
4 **Excessive wear of the wheel tyres**	Faulty steering wheel geometry	Check and adjust the wheel steering angles.

4.9.3. OPERATIONS TO BE PERFORMED ON REMEDYING

These operations have been already described in the chapter concentring the vehicle maintenance.

4.10. VEHICLE ELECTRIC EQUIPMENT

4.10.1 DESCRIPTION OF THE VEHICLE ELECTRIC EQUIPMENT

The ARO vehicle electric equipment with a 12 V voltage, fed by a storage battery and a three-phase alternator, provided with a built in rectifier. fier

There is also the variant for 24 V voltage, with two storage batteries, connected in series.

The main components of electric equipment are protected by 12 fuses, assembled in the fuse box, mounted in the glove box.

The vehicle electric equipment provide operation of the following vehicle units:

- Starter motor
- Engine
- Windscreen washer
- Windscreen wiper
- Heating ventilating system

The electric equipment provides also the operation of the following signalings:

- Marking lights (side lights)
- Direction signaling lights (flasher lamps)
- Head lights
- Mishap lights
- Electric horn
- Back up light
- Dash lights

The main components of the electric equipment, as well as well as their location on the vehicle, are indicated below in the Table XXXVIII:

TABLE XXXVIII

Ref. No.	Electric component or instrument	Symbol	Location on the vehicle
1	Storage battery	12DS 70-1	Under passenger seat
2	Key switch KC2	NID 1478-64	On the seat support, under passenger seat.
3	Alternator	Model 111	On the engine, driven by the fan belt
4	Starter motor	D 1.2-12 type 2130	On the engine, fastened on the clutch housing

			less than 5 mm, measured on the wheel mounted on vehicle, on the middle wheel diameter.
		Too large a play of the hub bearings	Check and adjust bearing play
3	**Wheel blocking**	Exccessive bearing tightening in the wheel hub	Check and adjust right play of the wheel bearings.
		Lack of lubricant the hub bearings	Lubricate the bearings.
4	**Excessive wear of the wheel tyres**	Faulty steering wheel geometry	Check and adjust the wheel steering angles.

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4	Starter motor	D 1.2-12 type 2130	On the engine, fastened on the clutch housing

5	Ignition distributor	Type 3231	On the engine, lateraly to L.H. side
6	Ignition coil	Type 1410	On the L.H. inner mud guard
7	Voltage regulator	Type 1410	Inside the cowl, on the R.H.
8	Cluster instrument	NIR 285-286	On the dashboard, symetricaly to steering wheel
9	Starter relay	Type 4815	On the outer side of the cowl, down, on the R.H.
10	Directions signalising relay	Type 4251	Inside the cowl, under the dashboard
11	Fuse box	Type 7937	Im the glove box
12	Hand lamp socket	A 30058	Below the dashboard
13	Trailer connecting plug	NI Lo27-61	On the vehicle rear panel
14	Heating fan motor	Type EA 422	On the cowl under the dashboard
15	Windscreen wiper motor	Type EP 3	On the cowl, under the dashboard
16	Lights switch cluster		On the steering column
17	Hand brake stop switch		On the brake lever support or on the lever
18	Main brake stop switch		Inside the cowl on the brake pedal
19	Ignition lock		On dashboard or steering column
20	Engine bonnet switch		Under the bonnet on the L.H. mud gaurd

21	Engine bonnet lamp		Under de bonnet on the L.H. mud guard
22	Starter relay Type 1670	NIR 361	Inside the cowl, on R.H.
23	Electric born Type 4120	NIR 276	Behind the grill panel
24	Oil pressure transmitter Type 5621	NIR 292	On the engine block, lateraly, L.H. middle side
25	Pressure gauge connector	NIR 298	Ditto, on the front side
26	Water temperature transmitter Type 5521	NIR 293	Ditto, on the rear side
27	Fuel level transmitter Type 5726	NIR 307	On the fuel tank upper face, under the body floor pan cover
28	Head light	FA 1m-170	On vehicle front'panel
29	Flasher lamps	ISF 6	On the R.H. L.H. body front corners
30	Combined flasher, stop tail lamp	DSP 7	On R.H. L.H. body rear corners
31	Back up lamp	NID 2665-70	Down, on the L.H. body corner.
32	Number plate rear lamp		On tailgate
33	Direction signalizing switch	NIR 351	On dashboard
34	Cab illumination rheostat swich	NII 506	On dashboard, on R.H.

35	Control lamp 7414	NII 513	On dashboard, on the middle
36	Electric cigar lighter		On dashboard in the middle
37	Cab illuminating lamp		Inside the cab

The electric equipment of the vehicles having Diesel engine, is similar with the above described standard equipment.

4.10.2 TROUBLES & REMEDYINGS OF THE ELECTRIC EQUIPMENT

The troubles which may occur in the vehicle electric equipment are accidental ones. The troubles of electric components, concerning the engine, have been indicated in the chapter concering the engine, while the other in the chapter concerning the vehicle maintenance.

In the below Table XXXIX are specified the troubles of the rest of electric equipment:

TABLE XXXIX

Ref. No.	Observed trouble	Posible cause	Manner of remedying
1	Fuses or bulbs are blowing	Short-circuit	Shoot the trouble and remedy it
2	Flasher lights do not operate	Fuses of bulbs blown out	Check and replace the faulty fuses or bulbs
3	Back up light do not operate	Back up switch faulty	

	Fuse or bulb blown out	Check and replace faulty component
4 On braking the stop lights do not light	Mecanical switch faulty	
	Interrupted connections	Check and replace faulty components
	Fuses or bulbs blown out	

4.11 THE VEHICLE BODY

4.11.1. DESCRIPTION OF THE VEHICLE BODY

The vehicle body consists of the substructure and the superstructure. The substructure is a metallic design for all ARO type vehicles.

The superstructure is a tilt framework, covered with textile tilt, for ARO 240 and 241 vehicles, completely metallic for the other ARO vehicle types. Depending on destination and vehicle model, the body can have 2 doors ARO 240, 242 and 320), 3 doors (ARO 243 m, 240 V) or 4 doors (aro 241 and 244).

The vehicle body consists of the following components, which can be detache or mecanically assembled:

- The vehicle body itself
- The doors
- The rear tailgates
- The superstructure
- The inner mud guards
- The outer mud guards
- The radiator grill panel

The body is fitted on the chassis by the agency of screws, rubber washers, mountings, spacers and thrust collars, placed between the chassis and the body.

4.11.2. BODY FAULTS AND THEIR REMEDYINGS

The faults which may occur on the body are of external character, due to different exttermal blows.

One of the frecvent faults, which can occur during the vehicle operation is the removing of its protective coat and apperance of the rust spots. To prevent this, it is indicated to wash periodidically the vehicle, insisting specially upon the substructure. After washing, inspect attentively the paint coat, on the body surface, and there where exist paint fissures or interruption, take immediately necessary measures to remedy the beginning paint coat damaging. In case the rust spot have appeared on the body surface, they should be removed by furbishing up to obtaining o clean area, and after that protect respective area with a coat of prime paint and with evergloss, of respective colour.

In case of the blows on body surface, depending on their importance, replace damaged body parts or remedy the faults.

The body remedying consists of truening the deformed areas, performed by specialized workers, using a set of universal tools for tinsmithing. In some cases it will be necessary to use also oxiacetylene flame. The success of these operations depends on the worker's skill and ability.

4.11.3 OPERATIONS TO BE PERFORMES ON BODY REMEDYING

OP. 2.1.50.10.0 TAKING BODY DOWN FROM VEHICLE

The body taking down involves also the taking down of some mechanical units of the vehicle.

Perform this operation in the following order:

- Take down radiator grill panel and separate cooling radiator from the grill panel.
- Undo electrical connections from all the lamps and headlamps, fitted on the vehicle body.
- Undo electrical connections between the vehicle electrical equipment and the engine.
- Dismantle connection between the steering wheel shaft and its flexible coupling.
- Disconnect storage battery and starter relay.
- Disconnet brake clutch main cylinders from hydraulic control system.
- Disconnect heating ventilating system.
- Unscrew bolts fastening the body on chassis, according to Fig. 4.160.

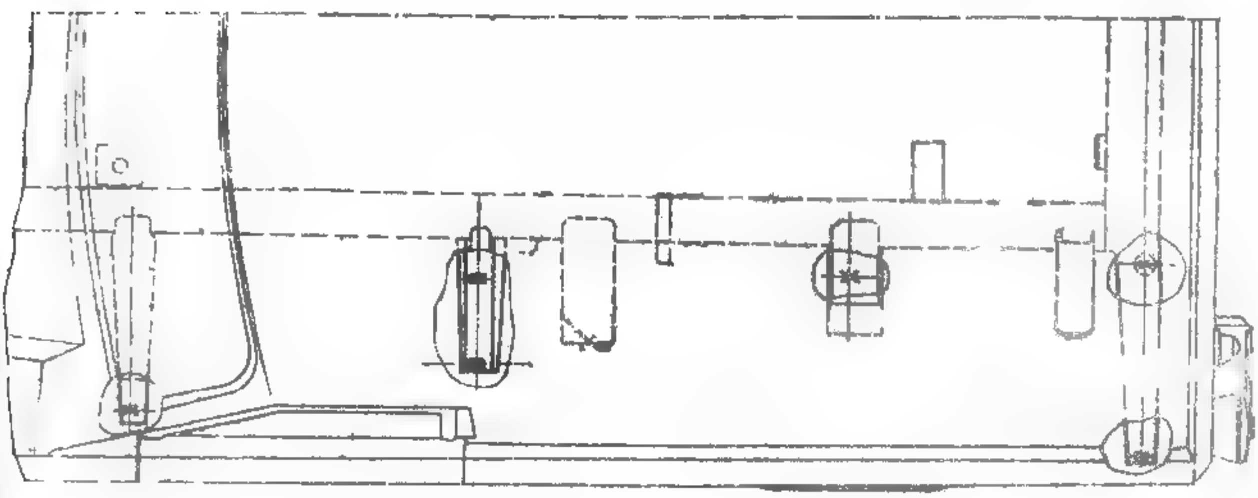

Fig. 4.160. BODY MOUNTING POINTS ON CHASSIS FRAME

- Undo connections from fuel level transmitter, hand brake switch, back up switch and speedometer flexible shaft.
- Fasten the body with D 151 lifting device, as shown in the Fig. 4.161, lift the body and set it on a storage place.

  On refitting the body on vehicle chaussis, perform the above stages in reverse order.

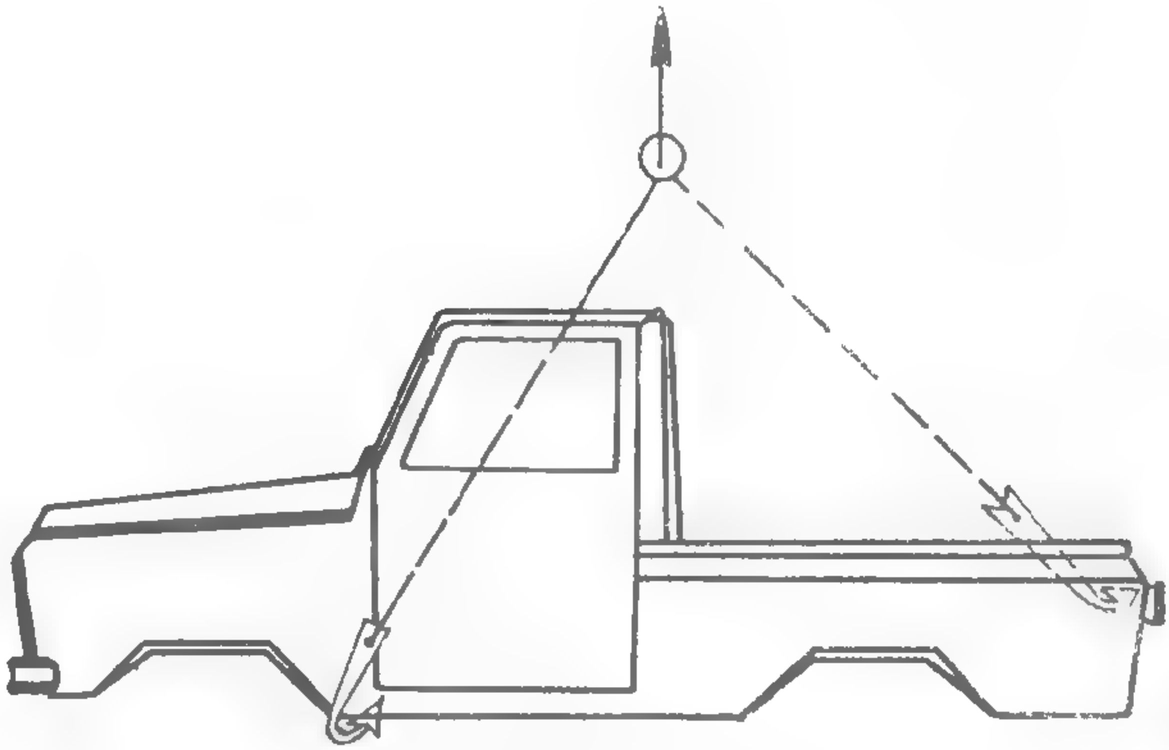

Fig. 4.161. FASTENING VEHICLE BODY BY MEANS OF D 151 LIFTING DEVICE.

OP. 2.1.50.02.0 DISMANTLING THE BODY

Diamantle the body in the following order:

- Engine bonnet
- Superstructure
- Brake & clutch master cylinder bracket
- Steering wheel shaft and column
- Electrical equipment
- Head lamps
- All other lamps
- U pholstery

Dismantle then the door, th: tailgates, radiator grill panel, inner and outer wings (mud guards).

On reassembling the body, set it on chassis without finally fastening then fit the grill panel, after having previously fitted the fan guard and the radiators (for water and oil); connect the radiators to engine, in order to give stability. Finally fit inner and outer wings.

Introduce a mastic belt between the steel contacts surfaces.

After refitting the mud guards, fasten the body finally to the vehicle chassis.

OP. 2.1.50.03.0 DISMANTLING ENGINE BONNET LOCK

In case of trouble (bonnet lock cable broken), remove the cable from control knob handle, by unscrewing the nut behind the dashboard (on the L.H.) and from the bonnet lock.

To get access to the bonnet lock it is necessary to take down the radiator grille and then to unscrew the two bolts on the upper side of the grille panel.

The cable should be bent on its end, as shown in the Fig. 4.162; the length which is to be bent will be established after refitting the bonnet lock on its place (See Fig. 4.163).

4.12. THE BODY WELDED ASSEMBLY

4.12.1. DISCRIPTION OF THE BODY ASSY.

The body assy. which equips ARO vehicles, consists of many components, assemblied by welding:

- The cowel carcase
- The L.H. front floor pan
- The R.H. front floor pan
- Seat suport box
- L.H. lateral panel

- R.H. lateral panel
- Windscreen frame

Fig. 1.162. ENGINE BONNET LOCK CONTROL CABLE FASTENING

4.12.2 FAULTS OF THE BODY ASSY AND THEIR REMEDYING

As a whole, the faults of the body assy have been described . in the chapter concerning the body.

The remedyings of the body assy should be carried out in the workshops endowed with oxiacethylenic welding facilities.

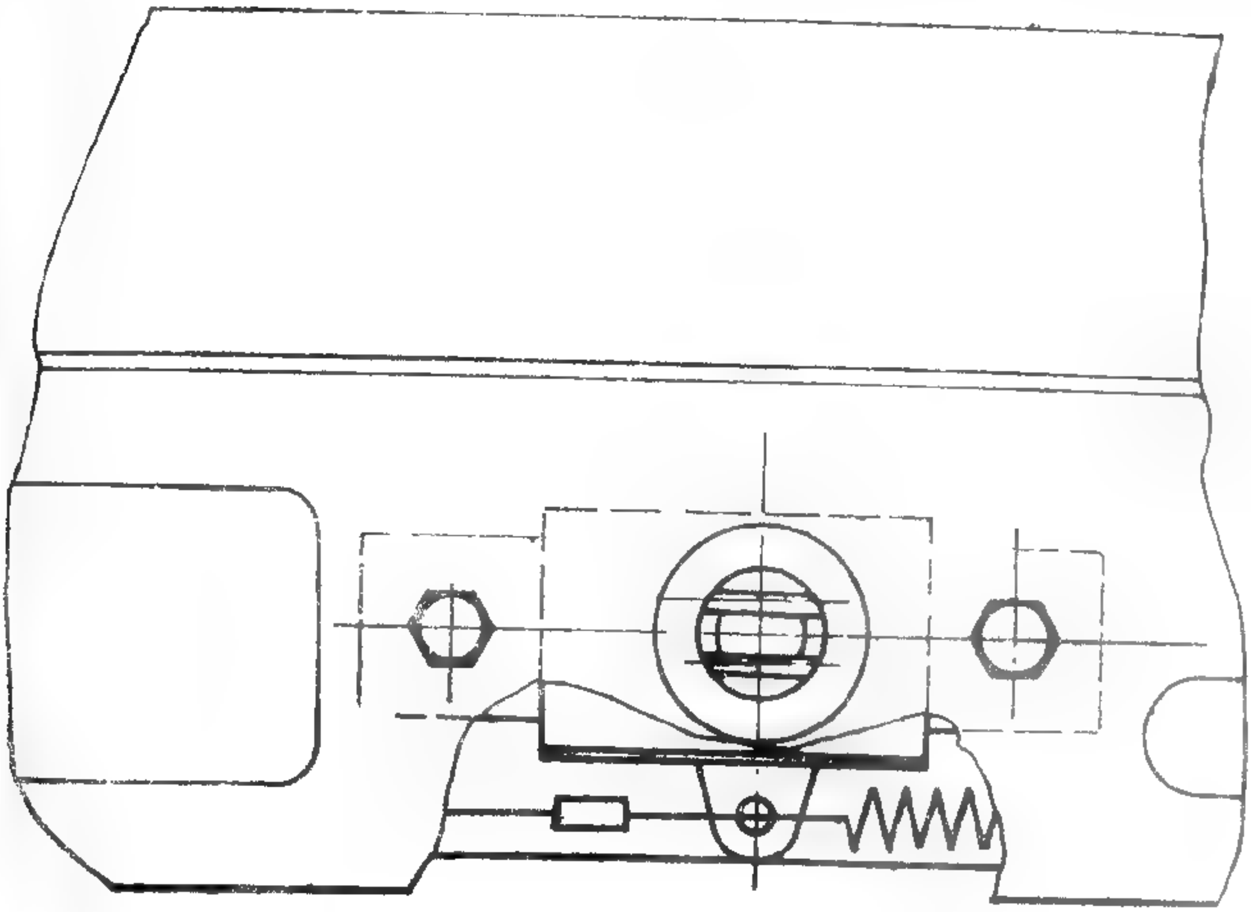

Fig. 4.163. ENGINE BONNET LOCK

4.13. WINDSCREEN AND WINDSCREEN WIPER & WASHER

4.13.1. DESCRIPTION OF THE WIND SCREEN AND ITS WIPER AND WASHER

The windscreen is the vehicle component which ensures visibility for the driver and passengers. In order to ensure permanently this aim the wind screen is equipped with washing and wiping auxiliary mechanisms.

The windscreen assy consists of: windscreen frame, welded on the cowl carcase (or, as a variant, tilting), windscreen glass and weather strip. The windscreen glass has a specific curved shape.

The windscreen wiper ensures the glass wiping (when it rains) by the alternative moving of two rubber blades (fitted on the end ot two arms, actuated by a small electric-motor). The wiped windscreen surface is shown in the Fig. 4. 164.

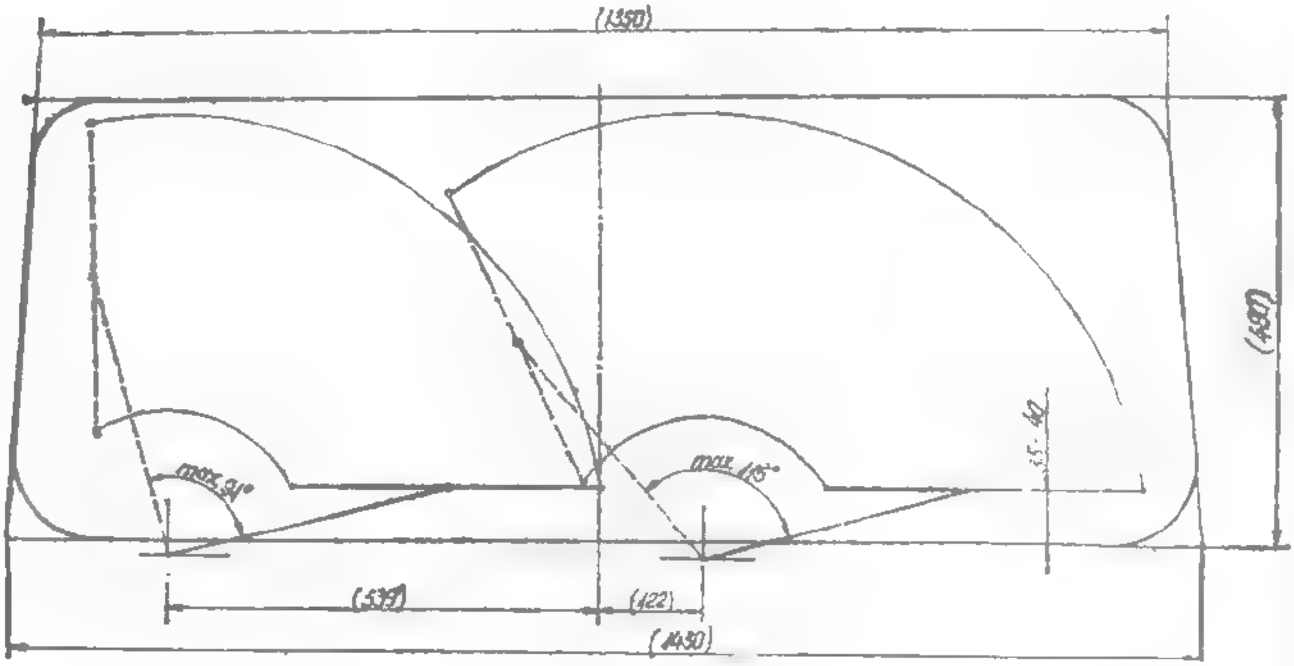

Fig. 4. 164. WINDSCREEN WIPING AREA

The components of windscreen wiper are shown in the Fig. 4. 165.

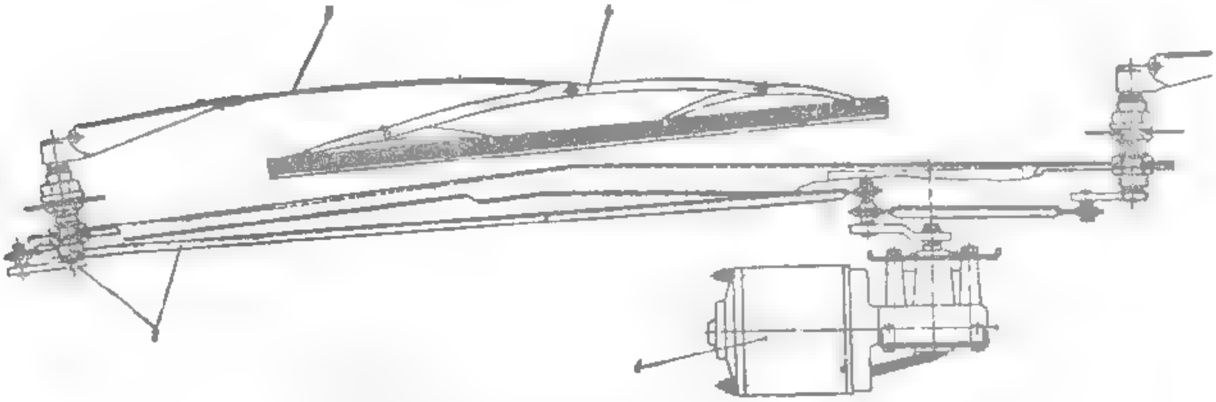

Fig. 4. 165. WINDSCREEN WIPER ASSY
1- Drive motor; 2- Drive mechanism; 3- Wiper arm; 4- Wiper blade.

The windscreen washer can be actuated electrically or mechanically (foot control.)

4.13.2. TROUBLES OF THE WINDSCREEN WIPER & WASHER AND THEIR REMEDYING

The troubles whith these assemblies are spontaneous. In the below Table XXXIX are given some possible troubles:

TABLE XXXIX

Ref. No.	Observed trouble	Possible cause	Necessary remedying
1	Windscreen wiper does not operate	Blown out fuse	Replace the fuse
		Faulty motor	Take down and replace faulty motor
2	Inedequate glass wiping	Wrong adjustment of the blades	Adjust blade right position.
		Damaged blades	Replace damaged blade
3	Windscreen washer does not operate	Faulty pump	Replace faulty pump.

4.13.3 OPERATIONS FOR REMEDYING WINDSCREEN AND ITS WIPER WASHER

OP. 2.0.25.01.0 REPLACING WINDSCREEN GLASS

- Remove windscreen glass, by removing the weather strip, beginning with its upper side.

- Fit weather strip along the new glass periphery, so that its both ends meet on the glass upper side. If dismantled weather strip is damaged, replace it by a new one.
- Now, fit the glass on the windscreen frame, from its outside and fit the strip edge inside the frame, using a screw driver, taking care that the weather strip covers the glass contour.

  REMARK : In the workshops is indicated the using a tool with cable, which is firstly introduced in the strip groove, pulling then the strip inwards.

OP. 2. 0. 52. 02. 0 TAKING DOWN & REMEDYING THE WINDSCREEN WIPER

In case of windscreen trouble (which can occur due to over-loading) it is necessary to dismantle the whole mechanism, in order to replace the damaged components.

As the electric motor and the drive mechanisme are located under the cowl dashboard, it will be necessary to remove some other parts, as follows

- Remove the windscreen wiper arms and the nuts fastening the drive shafts on the windscreen assy.
- Remove protecting covers, electric switches on the steering wheel column, steering wheel and the switch block.
- Remove from the dashboard instrument facia panel, without disconnecting electric leads, excepting those of wiper electric motor.
- Remove warm air demister funnel, the left side and remove it attentively, in order to make place for drive mechanism levers.
- Unscrew the screw fastening the wiper mechanism to the central panel and remove it out firstly from the windscreen (the shafts) and then from the cowl.

  On refitting performe the above stages in reverse order.

OP. 2.0.52.03.0 TAKING DOWN & REMEDYING THE WINDSCREEN WASHER

- Take down washer nozzles from the engine bonnet and remove the flexible pipes from the nozzles and the water reservoir.
- Take down pump assy and disconnect it.
- Replace faulty components and refitt all in reverse order.
- Orientate by hand both nozzles so that the the pumped water sprays adequate area the windsoreen.

4.14. THE BODY COWL AND ITS FACILITIES

4.14.1. DESCRIPTION OF THE COWL FACILITIES

The body cowl and the cab front side are fitted with the following facilities:

- Facia moulding
- Glove box
- Instrument facia panel
- Inside rear view mirror
- Transmission tunnel cover
- Sun visors, etc.

4.14.2. FAULTS & REMEDYINGS OF THE COWL FACILITIES

As a rule, these components cannot have troubles but only when damaged by knockings or by ageing after a time. These troubles can be remedied only by replacing faulty components.

4. 16 THE VEHICLE SUPERSTRUCTURE

4. 16. 1 DESCRIPTION OF THE VEHICLE SUPERSTRUCTURE

The ARO vehicle are provided with a superstructure, whose constructions differs dependiong on vehicle model.

So, the ARO 240 and 241 vehicles have a textile suprestructure, fitted on a metallic framework.

The ARO 243 and 244 vehicles have a completely metallic superstructure, with lateral windows.

For the ARO 242 and 320 vehicles (light pick-up truks) the superstructure consists of a metallic cab and a textile tilt, fitted on a metalic framework.

4. 16. 2. FAULTS & REMEDYINGS OF THE SUPERSTRUCTURE

The superstructure assembly has no specific faults. The faults which may occur are generally due to external causes (knockings).

The remedying of such of faults should be performed in the repair workshops.

4. 16. 3. OPERATIONS FOR REMEDYING THE VEHICLE SUPERSTRUCTURE

OP. 2. 0. 57. 01. 0 TAKING DOWN THE TILT

- Take down the tilt by removing all fastening straps from the clips welded on body, window frames and windscreen frame.
- Begin tilt removing from its back side, then fold the tilt towards the windscreen. Finally remove the fastening straps from the windscreen clips.
  In case of ARO 320 vehicle the tilt is removed by drawing out the fastening string, around the goods bucket, as well as the elements fastening the tilt on the framework.

OP. 2.1.57.02.0 TAKING DOWN THE TILT FARMEWORK

- Remove the tilt.
- Undo the two longitudinal straps (5) and, after that, remove the thre backstay tubes. (4).
- Remove rear hoop tube.
- Remove front hoop tube, and dump out bar (2) - Fig. 4.166).

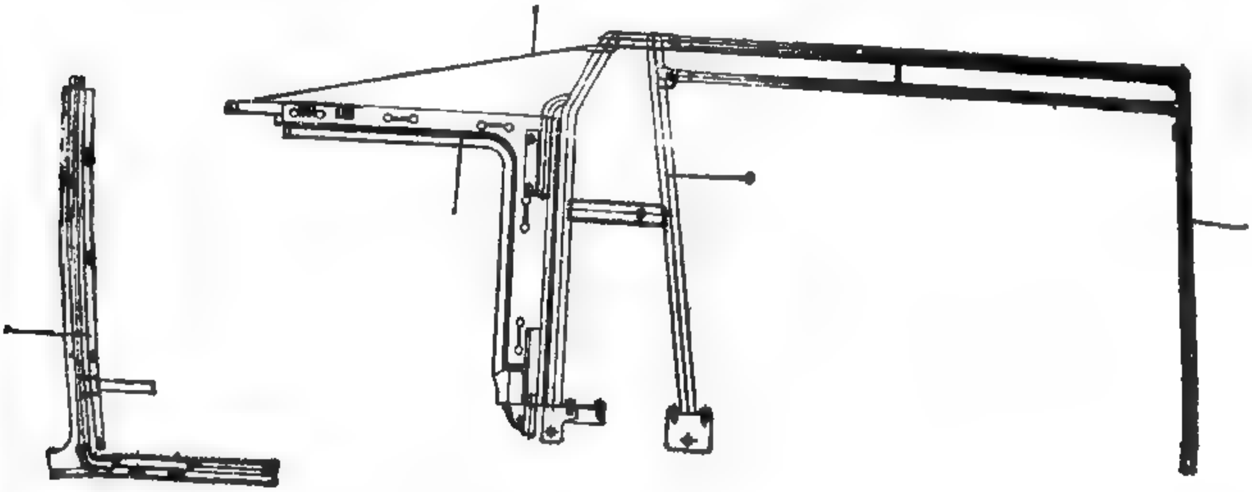

Fig. 4.166. TILT FRAMEWORK ASSY
1- Window frame; 2- Anti-capsize bar; 3- Rear hoop tube;
4- Connecting tube; 5- Strap; 6- Tilt frame

- Remove R.H. & L.H. door window frames and weather strips.

  Refitt the framework in reverse order (see Fig. 4.166).

OP. 2.0.57.03.0 TAKING DOWN THE METALLIC SIPERSTRUCTURE

- Remove the window panes from the superstructure.
- Remove upholstery (3) - see Fig. 4.167 -, after having removed the tensioners (5); remove then the rods (4) from their locations.
- Detach the felt insulating screens (2) from the superstructure.
- Take down the superstructure (1) from the body, by unscrewing the fastening bolts.

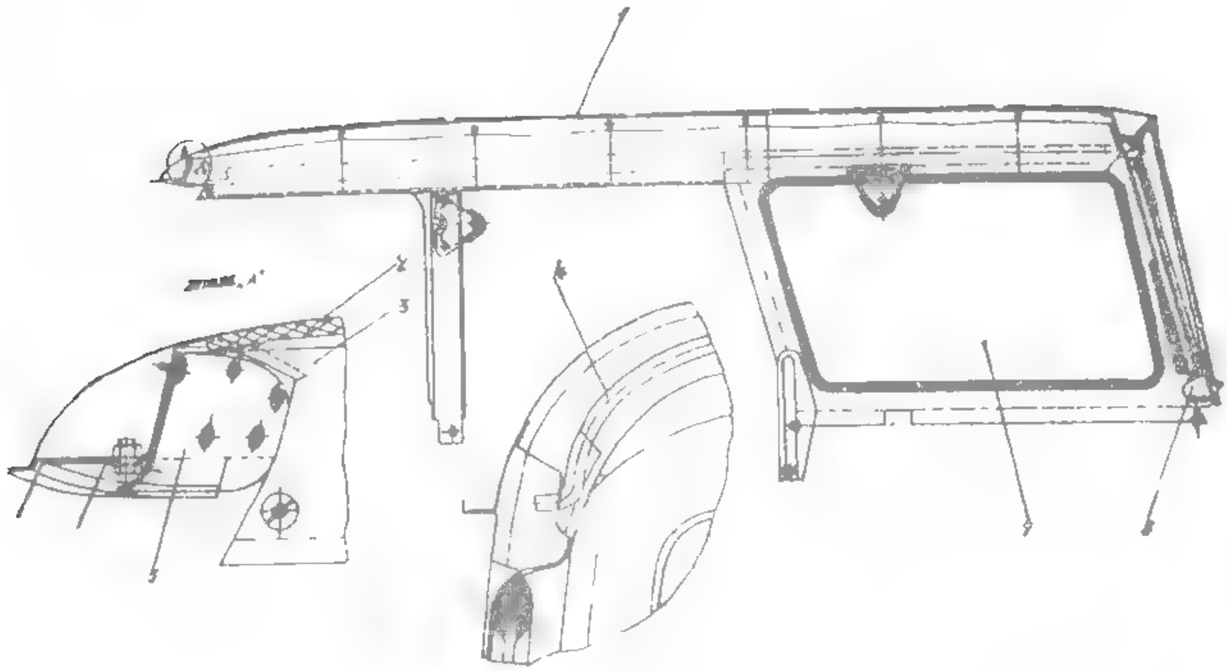

Fig. 4. 167. METALLIC SUPERSTRUCTURE ASSY
1- Welded superstructure; 2- Felt screen; 3- Upholstery; 4- Upholstery holding rods; 5- Upholstery tensioner; 6-Tailgate; 7- Side window.

- Remove ventilation cover (in case of ARO 243 vehicle).

On refitting the superstructure, perform the above stage in reverse order.

OP. 2. 0. 57. 04. 0 REPLACING THE UPHOLSTERY

Take down the upholstery and the window panes, acc. to Op. 2. 0. 57. 03. 0, except the felt screen, if it will be not necessary.

- Introduce the rods (4) in their locatinons, respecting the order of their mounting, because their length is not the same.

REMARK: Before introducing the rods in their locations, they should be introduced, in respective order, into the hollow hems (made by sewing on the new upholsters back side).

- Cut both ends of each hem (about 10-20 mm, similarly as on the old upholstery), in order to avoid the folding of the upholstery on its fitting. A longer scision of the hems will not let the upholstery follow the radius of body ceiling.

  The length of the new upholstery should be longer, on each end, with about 30 cm, as the real mounting length of the superstructure.
- Fit the new upholstery by introdusing the curved rods in their respective locations.
- Begin the upholstery fitting from the backside of the superstructure.
- Draw the upholstery forwards, longitudinally, so that the curved rods reach their normal position.
- Now, glue with adequate adhesive (for instance "Prenadez") the front and rear ends of the upholstery, which should be well stretched.
- Coat both front and rear tensioners with the same material as the upholstery itself.
- Fasten the tensioners on the superstructure, by means of the steel sheet screws.
- Stretch now the fitted upholstery laterally, glueing both R.H.& L.H. sides to the upper side of the windows, while in front of the rear door pillars bend the upholstery.
- In case of ARO 243 vehicle, on fitting ceiling upholstery, fit also the lateral tensioners.

4.17. THE FRONT SIDE DOORS

4.17.1 DESCRIPTION OF THE FRONT SIDE DOORS

All the ARO vehicle models have front side doors. The front side doors are equipped with descending window and pivoted ventilation window. The door window frame is fastened on the door body by means of the screws, a: can be detached.

The main components of the front side door are shown in the

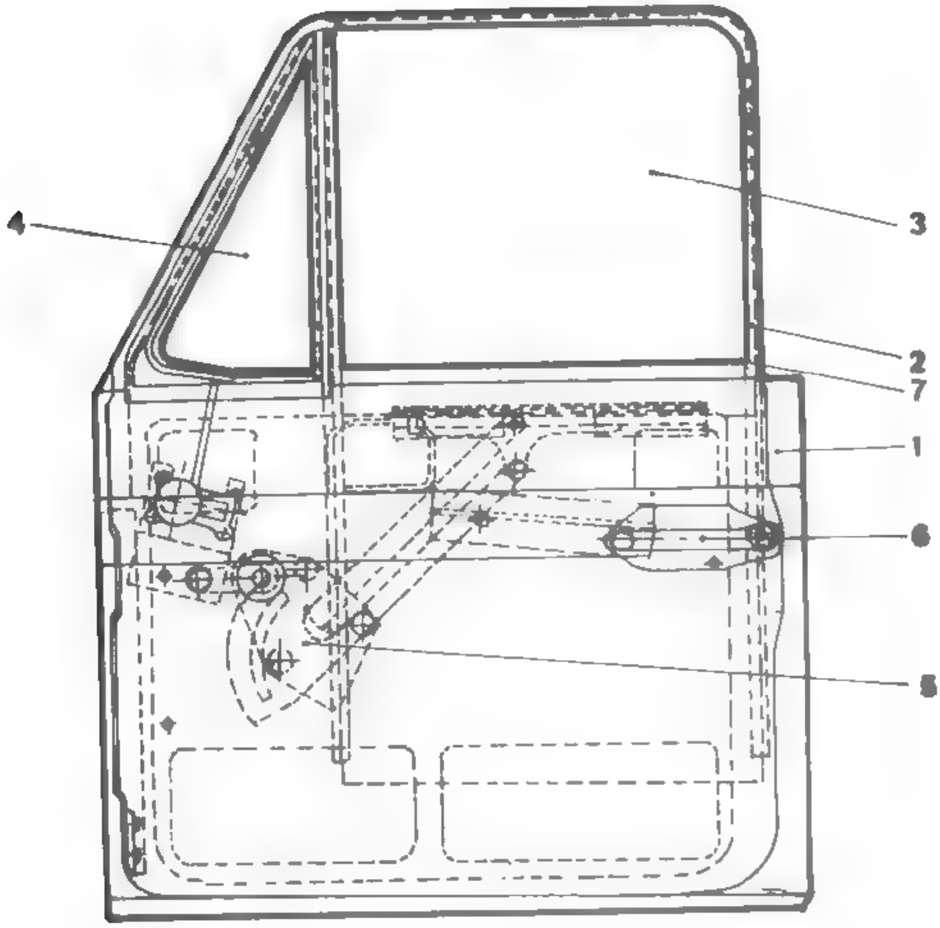

Fig. 4.168. FRONT SIDE DOOR
1- Door caracase; 2- Door window frame; 3- Descending window pane; 4- Pivoted ventilation window; 5- Descending window regulator; 6- Outside handle; 7- Inside door upholstery.

4.17.2 TROUBLES & REMEDYINGS OF THE FRONT SIDE DOORS

The troubles which may occur the front doors are accidental ones. So, the possible troubles may be:

- Disdjusting of the door lateral joints.
- Blocking of the window regulator (lifting/descending device).

4.17.3 OPERATION FOR REMEDYING FRONT SIDE DOOR TROUBLES

OP. 2.0.61.02.0 ADJUSTING DOOR JOINTS

The door joint adjusting should be performed so, as to let on each, lateral side a distance of 6 mm between the door and both body door pillars.

For adjusting the door joints actuate upon the door hinges, the door latches on the door pillar and upon the window frame, fastened on the door body

OP. 2.0.61.03.0 RFPLACING THE WINDOW REGULATOR

- Take down the door arm rest.
- Remove the window regulator crank.
- Remove inside handle shell.
- Remove the door window frame.
- Remove descending window pane.
- Take down window regulator.

On refitting new window regulator, performe the above stages in reverse order.

OP. 2.0.61.04.0 REPLACING THE VEHICLE FRONT DOOR

- Remove door check
- Take the door down from the hinges.
- Fit new door, by fastening the hinges and the door check on the door pillar
- Adjust door position in lateral plane and the door joints.
- Adjust door locking by changing position of the striker on the body pillar.

4.18 REAR SIDE DOORS

4.18.1 DESCRIPTION OF THE REAR SIDE DOORS

The ARO 241 and 244 vehicles have also two rear doors.

As a rule, they have same contstruction as the front doors.

The operations to be performed for remedying the failts are identical with those for remedying the front doors.

4.19 THE REAR DOOR

4.19.1 DESCRIPTION OF THE REAR DOOR ASSY

As a rule rear door equips the ARO 243, but on request, the ARO 240 vehicles can be equipped with the rear door.

It is a metallic, stiff construction, provided with a fixed window. It is fastened to the body and to the superstructure, with the hinges on one pillar and the lock latch on the other one. (see Fig. 169).

4.19.2 POSSIBLE FAULTS OF THE REAR DOOR AND THEIR REMEDYING

The faults cf the rear door are accidental and nor specific to this assembly. We can mean the following possible faults:

- Faulty door opening control.
- Faulty door lock.
- Broken window pane.
- Disadjusted door joints (between the door and the body).

4.17.3 OPERATION FOR REMEDYING FRONT SIDE DOOR TROUBLES

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The door joint adjusting should be performed so, as to let on each, lateral side a distance of 6 mm between the door and both body door pilars.

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- Remove the window regulator crank.
- Remove inside handle shell.
- Remove the door window frame.
- Remove descending window pane.
- Take down window regulator.

On refitting new window regulator, performe the above stages in reverse order.

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- Faulty door lock.
- Broken window pane.
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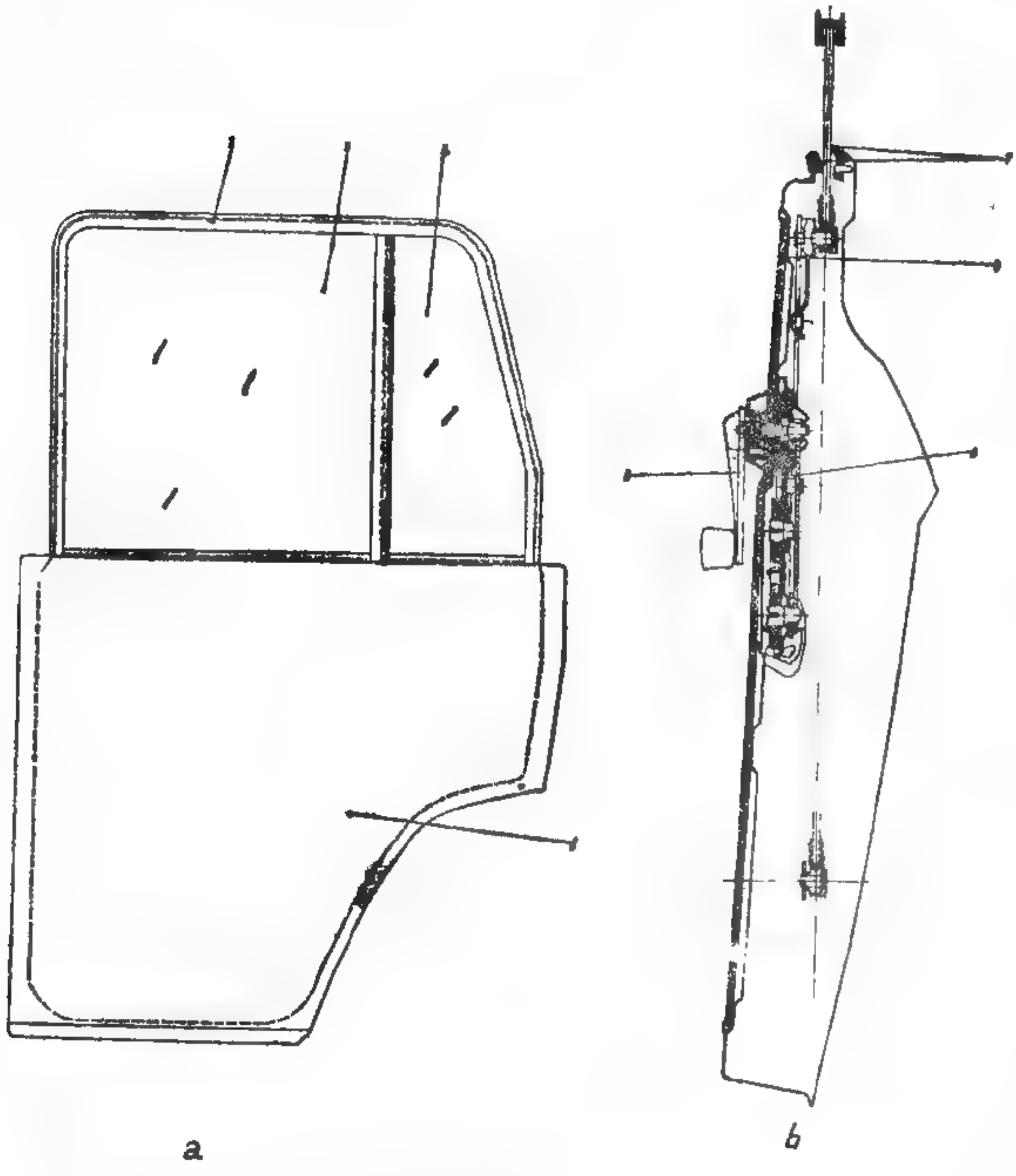

Fig. 4.169. REAR SIDE DOOR
1- Door carcase; 2- Door window frame; 3- Descending window pane; 4- Fixed window pane; 5- Window regulator; 6- Regulator handle; 8- Upholstery.

4.19.3 OPERATIONS FOR REMEDYING THE REAR DOOR TROUBLES

OP. 2.0.63.02.0 REPLACING DOOR OPENING CONTROL

- Remove inner door handle, by unsorewing the fastening screw and drawing out the bandle.

Remove inner rear door panel, towards the door lock, in order to get access to the lock.

- Unscrew the three bolts fastening the door opening control.
- Undo connection between the body rod and the lock lever (form the lock side).

After remedying, refitt components in reverse order.

OP. 2. 0. 63. 03. 0 REPLACING THE DOOR LOCK

- Remove inner door panel, from the lock side.
- Take down the lock by unscrewing the fastening bolts.
- Undo connection between the lock lever and the opening control rod.
- Remove the faulty lock.

After replacing the new lock, perform the above stages in reverse order.

4. 20 FRONT SEATS

4. 20. 1 DESCRIPTION OF THE FRONT SEATS

The ARO vehicles are equipped with two front seats, (driver and passenger seat). On special request the passenger seat of the ARO vehicles can be a double seat.

Both, driver's and passenger's seats are tilting. The seat's position can be adjusted along the vehicle axis, on the guides, fastened to the support box. For access to the storage battery both seats can be tilted inwards towards the vehicle axis. (see Fig. 4. 170).

4. 20. 2 TROUBLES OF THE FRONT SEATS AND THEIR REMEDYING

The troubles which may occur are accidental ones, such as:

- Blocking of the slide guides.
- Trouble of the seat bearing hinges.

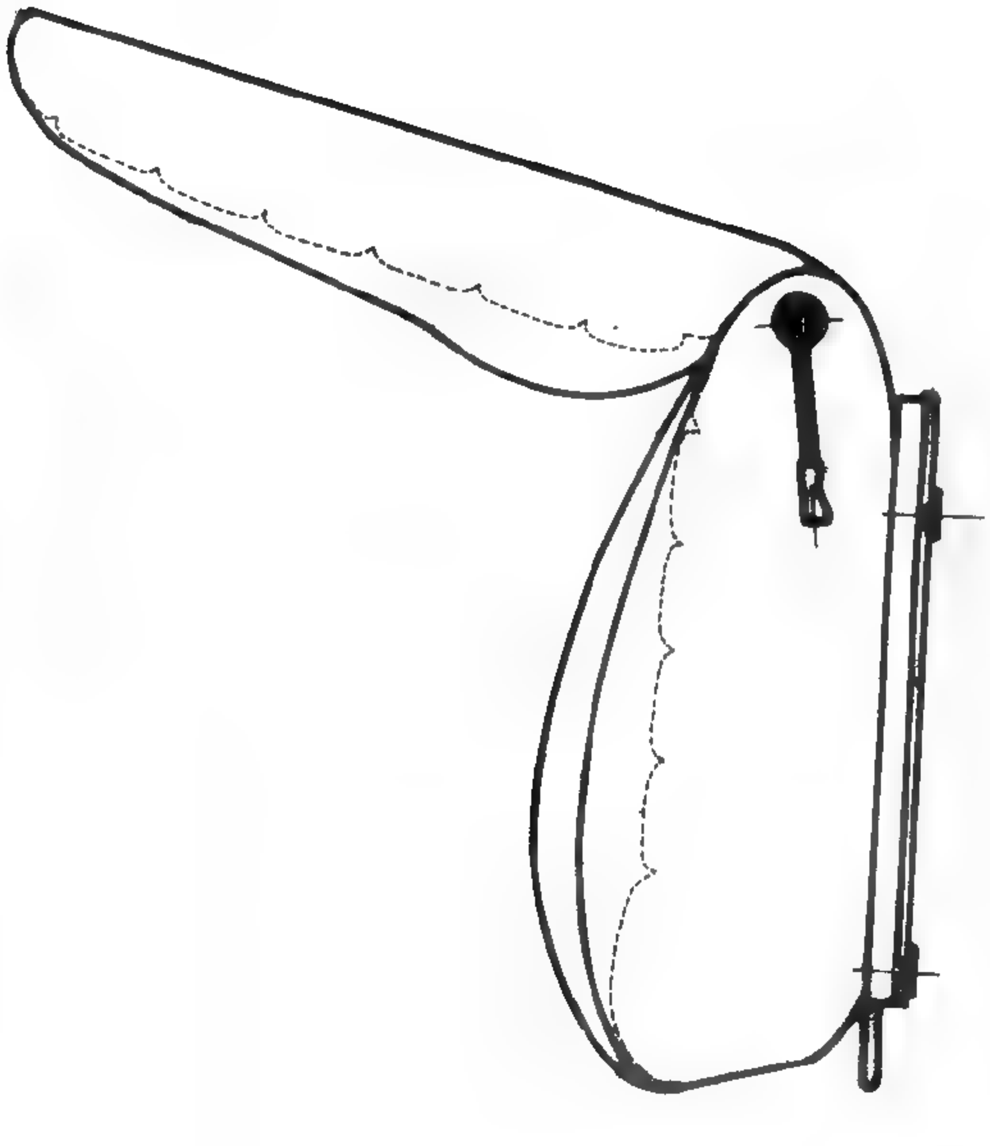

Fig.4 170 Front seat assy

6.3 OPERATION FOR REMEDYING THE SEAT TROUBLES

OP. 2.0.68.01.0 REPLACING THE SEAT

- Slide the seat forwards, until you get access to the bolt fastening the slide guide, at its rear side, towards the vehicle axis, and unscrew the bolt.
- Slide the seat backwards and unscrew the bolt which fasten the slide guide at the front side, towards the vehicle axis.
- Unscrew the bolts which fasten the slide guide at the door side.
- Remove the seat and replace it by a new one.

On refitting perform the above stages in reverse order.

OP. 2.0.68.02.0 REPLACING THE SLIDE GUIDES

- Take down the seat, as described in above operation 2.0.68.01.0
- Slide the guides and remove them form the seat support.
- Fit new guides.
- Fit the removed seat on its place.
- Check slide guide for correct operation.

OP. 2.0.68.03.0 REPLACING THE SEAT HINGE MECHANISM

- Take down the seat hinge mechanism, by unscrewing the four bolts fastening it on the seat support frame.
- Fit new hinge mechanism with the four bolts, unscrewed before. (see Fig. 4.170.

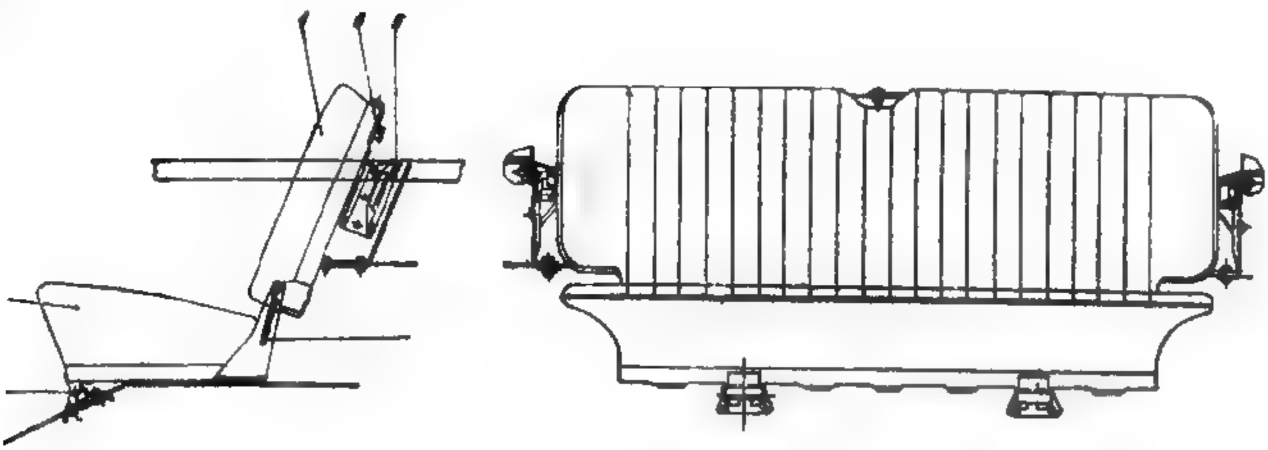

Fig. 4.171.
1- Rear seat back cushion; 2- Rear seat cushion; 3- Fixing hinge; 4- Tilting mechanism; 5- Fastening support; 6- Locking mechanism.

4.21 CROSS CUSHION REAR SEAT

4.21.1 DESCRIPTION OF THE CROSS CUSHION REAR SEAT

The cross cushion rear seat equips the ARO 241 and 244 vehicles. (see Fig. 4.171)

The cross cushion rear seat is tiltable, in order to increase the inner body place for luggages.

Its dismantling can be quickly carried out, its back cushion being fastened on supports by the agency of a locking mechanism (6) (see Fig. 4.171), while its fastening on the floor pane is secured by two supports

4.21.2 FAULTS & REMEDYINGS OF THE REAR SEAT.

The faults which may occur are accidental ones.

4.21.3 OPERATIONS TO BE PERFORMED FOR REAR SEAT REMEDYING

OP. 2.0.70.01.0 REPLACING THE LOCKING MECHANISM

- Tilt the back cushion, over the seat cushion.
- Take down the locking mechanism from the back cushion rear panel.
- Fit the new locking mechanism.
- Fasten the back cushion in its supports, by the agency of the locking mechanism.

4.22 HEATING VENTILATING SYSTEM

4.22.1 DESCRIPTION OF THE HEATING & VENTILATING SYSTEM

The heating & ventilating system is located in the engine area, being fitted on the vehicle body. It consists of: heater unit (3) - see Fig. 4.172 - fan assy (2), connecting duct (4), radiator water hoses (6) and flexible warm air pipes, heat adjusting tap (5). The heater unit is fitted on the grill panel and provides the air heating, by the agency of the in-built radiator, which receives necessary warm water, through the connecting pipes, between the heating unit and water pump and, between the heating unit and cylinder head.

- The warm circulation is provided by the fan (2), which causes a vacuum in the heating unit, delivering the warm air through the connecting pipe and flexible houses towards vehicle inside.
- The opening and shuting od the water flow is controlled by the agency of the adjusting tap (5), inserted between the heating unit and the cylinder head.
- The warm air flow is adjusted by the agency a air flap control, fitted in the connecting duct.
- The air flap and the heat adjusting tap are controlled from inside of the vehicle, respecive being mounted on the dashboard.

4.22.2 POSSIBLE TROUBLES, THEIR CAUSES AND NECESSARY REMEDYINGS

TABLE XV

Ref. No.	Observed trouble	Possible cause	Necessary remedying
1	Water leakages in the heating unit	Heating unit is leaking	It should be soft soldered
2	The adjusting tap is leaking	Damaged gaskets	Replace faulty gaskets
3	The system does not delliver warm air into the vehicle	The fan-motor unit is faulty	Replace the fan drive motor unit

OP. 2.0.81.01.0 TAKING DOWN THE HEATING UNIT FOR CHECKING, REMEDYING AND REFITTING

- Take down the grill panel.
- Disconnect the heating unit from the water inlet and outlet hoses (connecting it to cylinder head and water pump).
- Remove connecting sleeve between the fan and connecting duct.
- Slacken the fan from its support on the heating unit and move it away as far as possible from the heating unit.
- Unscrew the bolt fastening the heating unit to the grill panel and the two bolts fastening it on the cooling radiator.
- Remove the heating unit.
- Check heating unit for tightness, introducing compressed air under a pressure of about 0.5 bars, the unit being immersed in water.
- If necessary, remedy observed air leakages by soft soldering, after having completely dismantled the unit. Performe the soldering operation with much attention, because the unit radiator is assembled also by soft soldering.
- After checking or remedying refitt the heating unit in reverse order.

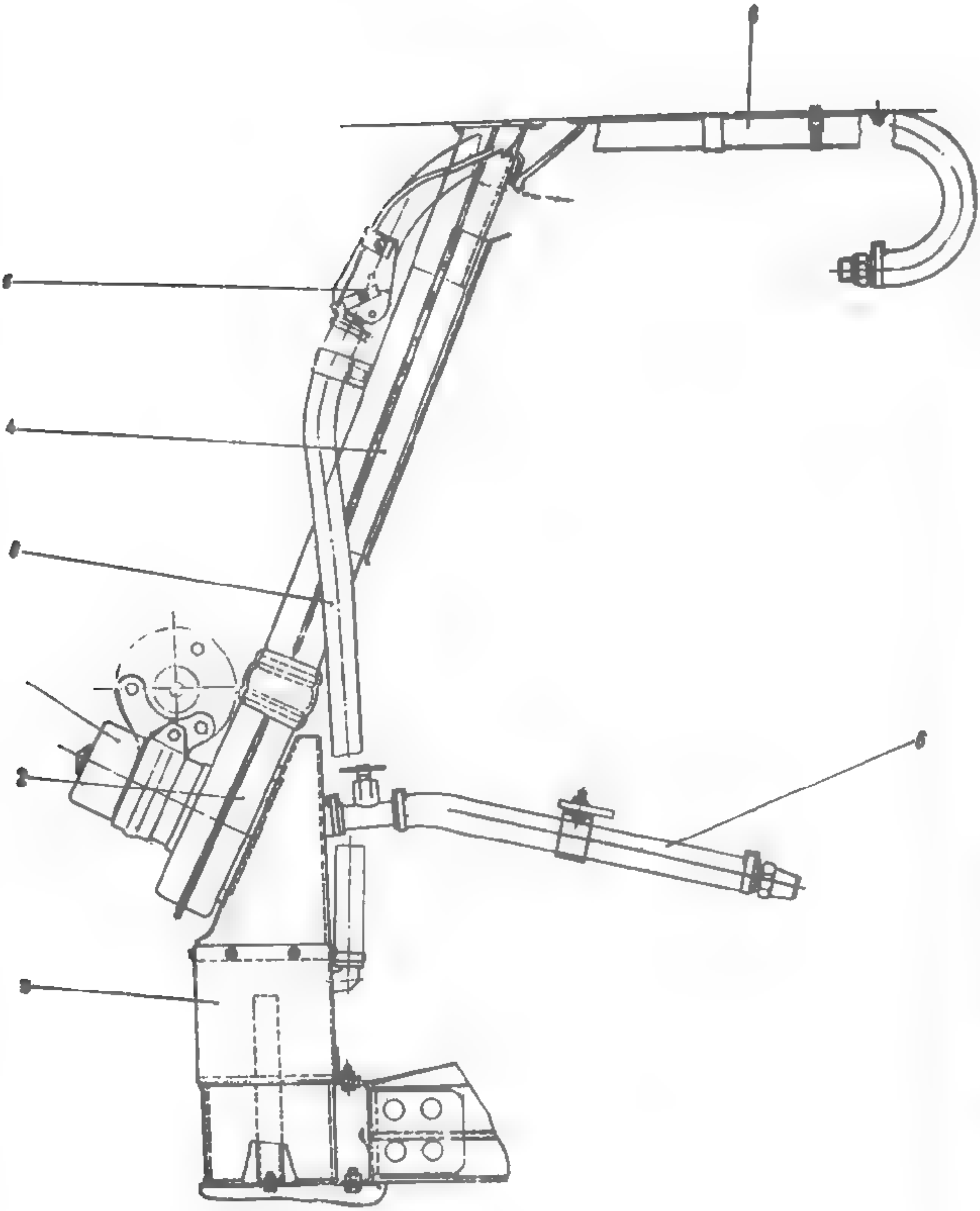

Fig. 4.172. HEATING VENTILATING SYSTEM
1- Fan motor; 2- Fan; 3- Heating radiator; 4- Connecting duct; 5- Heat adjusting tap; 6- Connecting hose.

OP. 2.0.81.02.0 REMOVING ADJUSTING TAP FOR CHECKING REMEDYING AND REFITTING

- Undo the control cable, by dismantling it from its support and from control lever.
- Remove the tap from the hose, connecting the heating unit with cylinder head (by slacking the hose clamps)
- Unscrew the nut fastening control lever and remove the lever.
- Remove cable support, by unscrewing the three slotted screws.
- Remove upper gasket, tap plug and lower gasket.
- Check all components for their good condition and replace the worn or damaged components.

  Refit all in reverse order, respecting their mutual position
- Check refitted tap for good operation (without jammings).

OP. 2.0.81.03.0 TAKING DOWN THE FAN FOR CHECKING, REMEDYING AND REFITTING.

- Remove connecting sleeve between the fan and connecting duct.
- Remove flexible connections from the drive motor.
- Slacken the bolt fastening the fan
- Unscrew bolts fastening the fan support on the vehicle and remove the fan together with its support.
- Remove the fan from its supprt.
- Unscrew the screws fastening the R.H. and L.H. housings.
- Draw out the fan rotor from its shaft, by unscrewing the locking screw.
- Take down the drive motor from the fan housing, by unscrewing the two nuts fastening it.
- Check the drive motor, and if faulty, replace it by a new one.

  Refit the fan in reverse order.

  REMARK: Before fitting the fan assy on the vehicle, check its operation, in order to observe if no vibrations or noises occur when operating.

ADVISE TO THE OWNER OF THIS HANDBOOK

On using this handbook it is recommended to consult always the SPARE PARTS LIST for ARO vehicles, where all the components of the vehicle are clearly represented and defined.

5. LIST OF SPECIAL TOOLS, DEVICE AND CHECKERS used for SERVICE operations

In order to facilitate the operations necessary for ARO 24 vehicles maintenace, repairs and overhauling, the manufacturer recommends to the customers the use of special tools, devices and checkers, in accordance with the following Tables 5.1 , 5.2, and 5.3.

5.1. SPECIAL TOOLS

Symbol	Denomination	Code No.	Operation the tools are meant for
S 101	Torque wrench for suspension	7813-4028	St. 5.0.99.10.1 St. 2.0.31.01.3
S 102	Nose pliers A	STAS+) 8066-67	St. 2.0.35.05.4
S 103	Wheel bearing nut wrench	7813-4013	St. 2.1.31.01.5
S 104	Mandrel for bearing pressing into brake drum hub	7853-4067	Op. 2.0.24.08.0
S 106	Mandrel of oil sealing ring pressing into brake drum hub	7853-4068	St. 2.1.31.01.5
S 107	Mandrel for drum mounting on the outer flange	7853-4071	St. 2.1.31.01.5
S 108	Mandrel for wheel hub bearing inner race pressing	7853-4072	Op. 2.0.24.08.0
S 109	Mandrel for brake master cylinder piston cup mounting	7853-4050	St. 2.0.35.05.1
S 110	Mandrel for cluth master cylinder piston cup mounting	7853-4047	St. 2.0.35.05.4
	Gearbox lever lock pin extractor	7853-4094	Op. 2.1.17.02.0

Symbol	Denomination	Code No.	Operation the tools are meant for
S 113	Special wrench for transfer box taking down	7813-4029	Op. 2. 1. 17. 04. 0
S 114	Primary shaft bearing snap ring removing pliers	7814-4045	Op. 2. 1. 17. 04. 0
S 115	Special wrench for gearbx power take off	7813-4030	Op. 2. 0. 43. 01.
S 116	Bushing for the bearing mounting on the gearbox power take-off inlet shaft	7853-4095	Op. 2. 1. 43. 02. 0
S 117	Busing for bearing mounting on gearbox power take off front housing	7853-4096	Op. 2. 1. 43. 02. 0
S 118	Mandrel for sealing ring depressing from power take-off rear housing	7853-4097	Op. 2. 1. 43. 03. 0
S 119	Pliers for cardan bearing snap rings	7814-4014	Op. 4. 1. 22. 06. 0
S 120	Spider bearing extractor	1041-4000	Op. 4. 1. 22. 06. 0
S 121	Sterring knuckle cover extractor	1041-4000	Op. 4. 1. 22. 06. 0
S 125	Handle for locating front differential axle shaft	7823-4091	Op. 4. 1. 23. 04. 0
S 126	Drive pinion inner bearing race extractor	7823-4074	Op. 4. 1. 23. 04. 0
S 127	Mandrel for depressing needle bearing from differential housing	7823-4085	Op. 4. 1. 23. 04. 0
S 128	Mandrel for sealing ring pressing into front differential housing (drive pinion)	7823-4081	Op. 4. 1. 23. 06. 0
S 129	Mandrel for mounting bearings into differential case	7853-4099	Op. 4. 1. 23. 07. 0
S 130	Special pliers for introducing assembled differential case into differential housing	7814-4046	Op. 4. 1. 23. 07. 0
S 131	Special wrench for front suspension	7813-4031	Op. 2. 0. 29. 07. 0

Symbol	D e n o m i n a t i o n	Code No.	Operations the tools are meant for
S 132	Mandrel for depressing front suspension ball joint sockets	7853-4100	Op. 2. 0. 29. 08. 0
S 133	Drive pinion inner bearing extracting bushing	7823-4030	Op. 4. 1. 23. 04. 0
S 134	Rear differential inner bearing mounting mandrel	7853-4101	Op. 4. 1. 24. 04. 0
S 135	Mandrel for mounting sealing ring into rear axle housing	7853-4070	Op. 2. 0. 24. 11. 0
S 136	Pliers for removing/mounting snap ring of belt pulley bearings	7814-4047	Op. 2. 0. 43. 05. 0
S 137	Special mandrel for sealing ring of driven shaft	7853-4102	Op. 2. 0. 43. 05. 0
S 138	Special mandrel for sealing ring of drive shaft	7853-4103	Op. 2. 0. 43. 05. 0
S 139	Bushing for pressing inner bearing on drive pinion	7823-4077	Op. 4. 1. 23. 06. 0
S 140	Bushing for presing outer bearing on drive pinion	7853-4104	Op. 4. 1. 23. 06. 0
S 141	Special wrench for clearance adjustment	7813-4407	Op. 4. 1. 24. 05. 0

3. 2. SPECIAL DEVICES

Symbol	D e n o m i n a t i o n	Code No.	Operations the devices are menat for
D 101	Brake drum extracting device	7823-4070	St. 2. 1. 31. 01. 5
D 102	Outer flange bearing race extracting device	7823-4124	St. 2. 1. 31. 05. 5
D 103	Hub sealing ring extracting device	7823-4125	St. 2. 1. 31. 01. 5
D 104	Brake drum bearing extracting device	7823-4066 7823-4065	Ditto Dito
D 105	Engine lifting device	7787-4003	Op. 2. 0. 10. 01. 0
D 107	Device for gearbox fastening on dismantling	7853-4105	Op. 2. 1. 17. 04. 0

Symbol	Denomination	Code No.	Operations the devices are meant for
D 108	Gearbox intermediate shaft extracting device	7823-4128	Op. 2. 1. 17. 07. 0
D 109	Gearbox intermediate shaft bearing extracting device	7823-4127	Op. 2. 1. 17. 07. 0
D 110	Reverse speed shaft extracting device	7823-4128	Op. 2. 1. 17. 08. 0
D 111	Device for fastening transfer box on dismantling	7853-4106	Op. 2. 1. 18. 04. 0
D 113	Device for extracting transmission shaft from transfer box housing	7823-4130	Op. 2. 1. 18. 07. 0
D 114	Device for extracting bearings from transfer box housing	7823-4131	Op. 2. 1. 18. 07. 0
D 115	Device for fastening gearbox power take-off	7853-4107	Op. 2. 1. 18. 09. 0
D 116	Device for blocking propeller shaft drive flange	7853-4108	Op. 2. 1. 18. 09. 0
D 117	Power take-off bearing extracting device	7823-4132	Op. 2. 1. 18. 09. 0
D 118	Device for dismantling propeller shaft intermediate bearing	7853-4109	Op. 2. 0. 43. 04. 0
D 122	Deving for removing brake shoes	7853-4112	Op. 2. 0. 30. 03. 0
D 123	Device for positioning brake anchor plate on dismantling	7821-4019	Op. 2. 0. 35. 04. 0
D 124	Adjustable device for differential sealing ring extracting	7823-4133	Op. 2. 0. 23. 06. 0
D 125	Adjustable device for extracting drive pinion outer bearing from differential housing	7823-4015	Op. 4. 1. 23. 04. 0
D 126	Device for fastening front differential housing for adjusting drive pinion clearance	7823-4079	Op. 4. 1. 23. 04. 0
D 127	Device for mounting differential case & crown wheel assy	7823-4053	Op. 4. 1. 23. 05. 0
D 128	Device for mounting differential pinions into differential case	7821-4015	Op. 4. 1. 23. 05. 0

Symbol	Denomination	Code No.	Operations the devices are meant for
D 129	Device for fitting bearing on front differential drive pinion	7823-4073	Op. 4. 1. 23. 06. 0
D 131	Device for pressing outer bearing on drive pinion	7823-4083	Op. 4. 1. 23. 06. 0
D 132	Device for fastening front differential housing & checking drive pinion axial play	8519-4092	Op. 4. 1. 23. 07. 0
D 133	Device for compressing front suspension coil springs	7823-4109	Op. 2. 0. 29. 05. 0
D 134	Manual device for compressing steering knuckle spring washers	7853-4113	Op. 2. 0. 29. 07. 0
D 135	Device for mounting front suspension upper control arms	7801-4011	Op. 2. 0. 29. 08. 0
D 136	Device for mounting front suspension upper control arm	7801-4009	Op. 2. 0. 29. 08. 0
D 137	Device for mounting front suspension lower control arm	7801-4008	Op. 2. 0. 29. 08. 0
D 138	Breacket for chassis suspending	7877-4004	Op. 2. 0. 29. 01. 0
D 140	Bench bracket for rear axle	7825-4031	Op. 2. 0. 24. 02. 0
D 141	Device for rear differential mounting	7825-4002	Op. 3. 1. 24. 03. 0
D [illegible]	Differential case bearing extracting device	7823-4025	Op. 4. 1. 23. 05. 0
D [illegible]	Device for extracting rear differential drive pinion inner bearing	[illegible]	Op. 3. 1. 24. 03. 0
D 144	Device for adjusting clearance in the rear differential	[illegible]	Op. 4. 1. 24. 05. 0
D 146	Rear spring bolt & washer extracting device	[illegible]	Op. 2. 0. 29. 05. 0
D 147	Belt pulley driven shaft bearing extractor	7823-4135	Op. 2. 0. 43. 05. 0
D [illegible]	Device for extracting drop arm from its control shaft	[illegible]	Op. 2. 0. 34. 08. 0

Symobl	D e n o m i n a t i o n	Code No.	Operations the devices are meant for
D 149	Device for extracting steering gear box bearings	7823-4136	Op. 2. 0. 34. 07. 0
D 150	Device for testing hydraulic control system tightness	7871-4034	Op. 2. 0. 35. 07. 0
D 151	Vehicle body lifting device	7875-4157	Op. 2. 1. 50. 01. 0

5. 3. SPECIAL CHECKERS AND MEASURING INSTRUMENTS

Symbol	D e n o m i n a t i o n	Code No.	Operations the checkers instru- ments are meant for
V 101	Brake & clutch pedal position checker	8532-4046	Op. 4. 1. 19. 02. 0
V 102	Front wheel toe-in checker	7821-4034	Op. 2. 0. 29. 02. 0
V 103	Brake shoes cylindrity meansu- ring instrument	8105-4007	Op. 2. 0. 34. 07. 0
V 104	Front differential housng sizes meansuring instrument	8539-4153	Op. 2. 0. 23. 04. 0
V 105	Front differential bearing width checker	8519-4087	Op. 4. 1. 23. 05. 0
V 106	Drive pinion standard washer	8519-4036	Op. 4. 1. 23. 06. 0
V 107	Drive pinion axial play checker	8553-4053	Op. 4. 1. 23. 06. 0
V 108	Drive pinion torque checker for adjusting bearing tightening	8519-4092	Op. 4. 1. 23. 06. 0
V 109	Special washer (6 ± 0.02 mm tickness) for adjusting drive pinion clearance	7853-4115	Op. 4. 1. 23. 07. 0
V 110	Micrometric gauge	8519-4093	Op. 4. 1. 23. 07. 0
V 111	Checker for rear differential drive pinion adjustment size	8532-4013	Op. 4. 1. 24. 04. 0
V 112	Drive pinion clearance checker	8590-4001	Op. 4. 1. 24. 04. 0
V 113	Device for checking steering worm bearing tightening	8540-4005	Op. 2. 1. 34. 10. 0
V 114	Clutch disc wobbling checker	8531-4003	Op. 2. 1. 16. 06. 0

Symbol	D e n o m i n a t i o n	Code No.	Operations the checkers instruments are meant for
V 401	Front differential gear clearance checker	8919-4171	Op. 4. 1. 23. 07. 0

SUPLIMENTAL TOOLS & DEVICES

S 301	Special retaining wrench for unscrewing brake piston nut	7813-4041	St. 2. 1. 35. 05. 2
S 302	Special mandrel for fitting brake piston cup on piston	7853-4151	St. 2. 1. 35. 05. 2
S 302	Ditto	8542-4007	St. 2. 1. 35. 05. 2
S 401	Special wrench for differential bearing clerance adjusting slotted nuts	7812-4019	Op. 4. 1. 23. 07. 0

5. 4. SPECIAL TOOLS, DEVICES & CHECKERS FOR ARO L-25 ENGINE OVERHAULING

Symbol	D e n o m i n a t i o n	Code No.	Operations the tools are meant for
S 1	Special chisel for locking clutch release lever adjusting screws (by caulking their taper holes)	7821-4095	Op- 2-1-16. 04. 0
S 2	Lever for clutch release fork mounting	7821-4090	Op. 2. 1. 16. 04. 0
S 3	Milling cutter for inlet valve seat reconditioning	2282-4016	Op. 3. 1. 03. 04. 0
S 4	Milling cutter for exhaust valve seat reconditioning	2282-4017	Op. 3. 1. 03. 04. 0
S 5	Drive shaft for milling cutters	6280-4001	Op. 3. 1. 03. 04. 0
S 6	End milling cutter for valve seat reconditioning	7853-4124	Op. 3. 1. 03. 04. 0
S 7	60°- tapered milling cutter for valve seat reconditioning	2282-4034	Op. 3. 1. 03. 04. 0

Symbol	Denomination		Operations the tools are meant for
S 8	Special drift for pressing in valve seats	7853-4124	Op. 3. 1. 03. 04. 0
S 9	Device for cleaning out piston grooves	7823-4124	Op. 4. 1. 04. 02. 0
S 10	Pliers for fitting piston pins snap rings	7821-4012	Op. 4. 1. 04. 02. 0
S 11	Pliers for fitting piston rings in piston grooves	7814-4012	Op. 4. 1. 04. 02. 1
S 12	Feeler gauge for checking side clearance of piston rings	LG 001	Op. 2. 1. 05. 02. 0
S 13	Bushing for pressing distributions drive gear on crankshaft	7801-4002	Op. 4. 1. 02. 06. 0
S 15	Drift set for pressing camshaft bushes in and out	7853-4041	St. 4. 1. 02. 06. 3
S 16	Pressing drift for inserting asbestos half-rings	7853-4042	St. 4. 1. 02. 06. 4
S 17	Assembling sleeve for fitting piston rings on piston	7853-4016	Op. 4. 1. 04. 02. 0
S 303	Special adapter for fitting gaskets into injection pump (Diesel)	2850-4014	Op. 4. 1. 14. 05. 0 D
S 501	Special tool for removing carbon deposit fuel injector atomizer delivery chamber	2850-4012	St. 3. 1. 01. 15. 0 D
S 502	Drift with needles for cleaning fuel injector cone body	2850-4012	St. 3. 1. 01. 15. 0 D
S 303	Device for extracting cylinder liner (Diesel engine)	7853-4198	Op. 2. 1. 07. 01. 0
D 4	Splined centering drift for centering clutch disc	7851-4000	Op. 2. 1. 16. 19. 0
D 5	Special rotating device for fastening engine on dismantling	7821-4089	Op. 2. 0. 10. 01. 0
D 6	Devuce for taking down valves	7823-4019	Op. 2. 1. 03. 01. 0

Symbol	D e n o m i n a t i o n		Operations the devices are meant for
D 7	Device for removing valve springs	7821-4009	Op. 2. 1. 03. 01. 0
D 8	Device for extracting valve guides	7823-4122	Op. 2. 1. 03. 03. 0
D 9	Device for lapping valves with their seats	7859-4001	Op. 3. 1. 03. 04. 0
D 10	Device for extracting exhaust valve seat	7823-4123	Op. 3. 1. 03. 04. 0
D 11	Complex device for checking valves	8531-4052	Op. 3. 1. 03. 05. 0
D 12	Dial gauge device for checking clearnce between valves & guides	8590-4005	Op. 3. 1. 03. 03. 0
D 13	Device for unscrewing screwing in starting ratchet	7812-4008	Op. 3. 1. 10. 01. 3
D 14	Crankshaft pulley extracting device	7823-4017	Op. 3. 1. 10. 01. 3
D 15	Device for extracting camshaft gear	7623-4018	Op. 2. 1. 05. 02. 0
D 17	Fastening devicc for grinding & honing cylinder liners	7116-4003	Op. 4. 1. 02. 06. 1
D 18	Engine cranking device	7820-4003	Op. 4. 1. 04. 02. 1
D 19	Alternator pulley extracting device	7823-4143	Op. 4. 1. 37. 02. 1
D 21	Cylinder head fastening device	7821-4095	Op. 3. 1. 03. 03. 0
D 501	Injection checking device	[redacted]	St. 3. 1. 01. 15. 0 D
D 502	Atomizer needle fastening device	7853-4196	St. 3. 1. 01. 15. 0 D
D 304	Device for pressing in cylinder liners	7853-4199	Op. 2. 1. 07. 01. 0
V 1	V-belt pulleys' coplanarity checher	7821-4001	Op. 4. 1. 04. 02. 3
V 2	Dial gauge checker for valve [redacted]	8332-4002	Op. 4. 1. 10. 08. 0

Symbol	Denomination		Operations the tools are meant for
S 8	Special drift for pressing in valve seats	7853-4124	Op. 3. 1. 03. 04. 0
S 9	Device for cleaning out piston grooves	7823-4124	Op. 4. 1. 04. 02. 0
S 10	Pliers for fitting piston pins snap rings	7821-4012	Op. 4. 1. 04. 02. 0
S 11	Pliers for fitting piston rings in piston grooves	7814-4012	Op. 4. 1. 04. 02. 1
S 12	Feeler gauge for checking side clearance of piston rings	LG 001	Op. 2. 1. 05. 02. 0
S 13	Bushing for pressing distributions drive gear on crankshaft	7801-4002	Op. 4. 1. 02. 06. 0
S 15	Drift set for pressing camshaft bushes in and out	7853-4041	St. 4. 1. 02. 06. 3
S 16	Pressing drift for inserting asbestos half-rings	7853-4042	St. 4. 1. 02. 06. 4
S 17	Assembling sleeve for fitting piston rings on piston	7853-4016	Op. 4. 1. 04. 02. 0
S 303	Special adapter for fitting gaskets into injection pump (Diesel)	2850-4014	Op. 4. 1. 14. 05. 0 D
S 501	Special tool for removing carbon deposit fuel injector atomizer delivery chamber	2850-4012	St. 3. 1. 01. 15. 0 D
S 502	Drift with needles for cleaning fuel injector cone body	2850-4012	St. 3. 1. 01. 15. 0 D
S 303	Device for extracting cylinder liner (Diesel engine)	7853-4198	Op. 2. 1. 07. 01. 0
D 4	Splined centering drift for centering clutch disc	7851-4000	Op. 2. 1. 16. 19. 0
D 5	Special rotating device for fastening engine on dismantling	7821-4089	Op. 2. 0. 10. 01. 0
D 6	Devuce for taking down valves	7823-4019	Op. 2. 1. 03. 01. 0

Symbol	Denomination		Operations the devices are meant for
D 7	Device for removing valve springs	7821-4009	Op. 2. 1. 03. 01. 0
D 8	Device for extracting valve guides	7823-4122	Op. 2. 1. 03. 03. 0
D 9	Device for lapping valves with their seats	7859-4001	Op. 3. 1. 03. 04. 0
D 10	Device for extracting exhaust valve seat	7823-4123	Op. 3. 1. 03. 04. 0
D 11	Complex device for checking valves	8531-4052	Op. 3. 1. 03. 05. 0
D 12	Dial gauge device for checking clearnce between valves & guides	8590-4005	Op. 3. 1. 03. 03. 0
D 13	Device for unscrewing screwing in starting ratchet	7812-4008	Op. 3. 1. 10. 01. 3
D 14	Crankshaft pulley extracting device	7823-4017	Op. 3. 1. 10. 01. 3
D 15	Device for extracting camshaft gear	7623-4018	Op. 2. 1. 05. 02. 0
D 17	Fastening device for grinding & honing cylinder liners	7116-4003	Op. 4. 1. 02. 06. 1
D 18	Engine cranking device	7820-4003	Op. 4. 1. 04. 02. 1
D 19	Alternator pulley extracting device	7823-4143	Op. 4. 1. 37. 02. 1
D 21	Cylinder head fastening device	7821-4095	Op. 3. 1. 03. 03. 0
D 501	Injection checking device	8524-4008	St. 3. 1. 01. 15. 0 D
D 502	Atomizer needle fastening device	7853-4196	St. 3. 1. 01. 15. 0 D
D 304	Device for pressing in cylinder liners	7853-4199	Op. 2. 1. 07. 01. 0
V 1	V-belt pulleys' coplanarity checher	7821-4001	Op. 4. 1. 04. 02. 3
V 2	Dial gauge checker for valve seats	8332-4002	Op. 4. 1. 10. 08. 0

Symbol	D e n o m i n a t i o n		Operations the devices are meant for
V 5	Micrometric device for measuring distance between end of valve stem and botton of disc	8321-4025	Op. 3. 1. 03. 04. 0
V 3	Checker for inlet valve seat	8530-4010	Op. 3. 1. 03. 04. 0
V 6	Complex checker for piston rods twist, flexure & length checking	8513-4000	Op. 3. 1. 03. 05. 0

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